Forward-Rate Bias, Imperfect Knowledge, and Risk: Evidence from Developed and Developing Countries

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Abstract

This paper examines the stability of the basic regression underpinning the forward-discount anomaly for 20 developed and 32 developing countries. It finds that the correlation between the change of the spot exchange rate and forward discount is piece-wise linear in every country, involving stretches of time in which forward-rate bias is negative and other stretches of time in which it is positive. The results also point out to a new empirical finding that the average magnitude of the positive and negative biases that are found in each developed country tends to be larger than those for developing countries. The paper shows that a new risk premium model based on Imperfect Knowledge Economics can account for this pattern across developed and developing countries, thereby undercutting the widespread view in the literature that developed-country currency markets are characterized by a greater degree of irrationality than those for developing countries.

Keywords: IKE risk-premium model, forward-rate biasedness, exchange rate persistence, half-life, SETAR model

1 Introduction

In this paper, I examine one of the core puzzles in International Macroeconomics, the so-called "forward-discount anomaly." Hundreds of studies regress the one-period-ahead change in the spot exchange rate on the forward premium – henceforth called the Bilson (1981)-Fama (1984) (BF) regression – without making any allowance whatsoever for the possibility that the process underpinning exchange-rate movements may have changed, at least intermittently, over the modern period's four decades of floating rates. Researchers report estimates of the slope coefficient that are not only less than unity, but less than zero. A slope coefficient that is less than unity implies that the forward premium is a negatively biased predictor of future changes in the spot exchange rate. A slope coefficient that is negative implies that spot-rate changes tend to be in the opposite direction of that predicted by the forward premium.[2] Interpreting their results as implying a stable relationship in the data,

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[2]See Froot and Thaler, 1990, Lewis (1995) and references therein.

international macroeconomists conclude that "one can make predictable profits by betting against the forward rate" (Obstfeld and Rogoff, 1996, p. 589).

The inability of risk-premium models that are based on the rational expectations hypothesis (REH) to account for a large negative bias has led researchers to develop behavioral-finance models in which a negative bias arises because market participants fall prey to systematic forecasting biases and technical trading.[3] In these models, speculators could earn greater profits simply by betting against the forward rate, but they pass up this obvious opportunity. Such gross irrationality arises because speculators are assumed to underreact or overreact to news or make use of chartists rules in a way that remains fixed over time.[4]

Frydman and Goldberg (2007) and Frydman, Goldberg, and Kozlova (2013a) advance an alternative explanation of the discount anomaly: it is a byproduct of presuming that a single conditional probability distribution can account for the process underlying exchange-rate movements over many decades. In currency and other asset markets, participants revise their forecasting strategies, at least from time to time, as their understanding of the market process develops, and as economic policy and other features of the social context within which they make their trading decisions also change. Such change would lead to shifts in the exchange-rate process, and thus to instability in the BF regression. Frydman, Goldberg, and Kozlova (2013a) test this conjecture in three major currency markets and find that in each one there are stretches of time in which the BF slope coefficient is negative, while during other stretches of time it is positive and either less than, equal to, or greater than one.[5]

This instability contradicts behavioral-finance models' assumption that speculators invariably overreact or underreact in a fixed way, as well as their prediction of a negative forward-rate bias. As Fama has observed, "apparent overreaction to information is about as common as underreaction, and post-event continuation of pre-event abnormal returns is about as frequent as post-event reversals" (Fama, 1998, p. 283). The instability of the BF regression also goes a long way toward resolving the forward-discount anomaly. It implies that always betting against the forward rate will deliver profits at some times and losses at others. No one can fully foresee ahead of time when the correlation between the future change in the spot rate and the forward premium might be negative and for how long, so no one can foresee when it might be profitable to bet with or against the forward rate.

Recent research has estimated the BF regression for a wide variety of countries. Ignoring the structural instability, these studies again conclude that the forward rate is negatively biased. Moreover, their pooled regressions indicate a supposedly new finding: the size of the negative bias is estimated to be greater in developed than in developing countries. Frankel and Poonawala (2010) have suggested that this difference between the developed and developing countries arises because markets for major currencies are characterized by a greater degree of irrationality. Burnside et al. (2011) develop a model in which participants overreact to news in both developed- and developing-country markets, but the overreaction is larger in the major currency markets, thereby leading to greater forward-rate bias.[6]

In section 2, I show that, as for the three major currencies, the finding of a negative bias for developed and developing countries is an artifact of ignoring its instability, rather than an anomaly suggesting that market participants ignore obvious profit opportunities. I test the stability of the BF regression in a sample of 20 developed and 32 developing countries. In carrying out this analysis, I use recursive procedures that do not impose break points a priori. These procedures enable me to recognize that neither market participants nor economists can foresee when or how they might revise their understanding of the process driving market outcomes

[3]For a review article on the failure of REH risk premium models, see Engel (1996).

[4]For example, see Mark and Wu (1998) and Gourinchas and Tornell (2004).

[5]We find such instability in the British pound, German mark, and Japanese yen markets over a sample period that includes the 1970's, 1980's, and 1990's. Other studies that also find results that depend on the sub-period examined include Bekaert and Hodrick (1993), Lewis (1995), Engel (1996), and Mark and Wu (1998).

[6]Burnside et al. (2009) develop a market micro-structure model that predicts greater bias in developed countries because informed speculators' access to private information matters more in those countries. See also Bacchetta and van Wincoop (2005, 2010), who argue that their model of rational inattention can account for variations in the forward-rate bias across developed and developing countries.

and alter their forecasting strategies.[7]

The analysis, with its focus on structural change, supposes that the BF regression undergoes shifts at discrete points of time, implying a piece-wise linear correlation between the future change of the spot rate and the forward premium. As with the results for the three major currencies, I find that the BF slope coefficient is positive and either less than, equal to, or greater than unity during some stretches of time and negative during others in every currency market that I examine. These results provide much additional evidence against behavioral-finance models.

They also call into question the finding that developed countries' forward rates tend to be characterized by greater negative biasedness. Like other studies, I find that when countries are pooled together and the structural change is ignored, the sample of developed countries is characterized by a negative bias that is larger than that for our sample of developing countries.

However, once the analysis is open to the possibility of structural change, I find for every country subperiods in which the bias is positive and other subperiods in which it is negative. In the face of such instability, pooling countries and ignoring structural change produce regression results that have little meaning. Such analysis merely obscures the changing correlations in the data.

Although I find that the bias for each country is not uniformly negative over the sample period, I can still ask whether the average magnitude of the positive and negative biases is greater in developed than in developing countries. In section 3, I average the absolute values of our estimates of the slope coefficient from the distinct linear pieces of the data for each country. Doing so reveals a striking result: although countries in both groups are characterized by both positive and negative biases over the sample periods, developed countries are characterized by a larger average bias than developing countries. In fact, I find that this tendency is more pronounced than the tendency that I and other researchers find based on pooled regressions.

These results also show that what needs to be explained is not a negative BF slope coefficient, but rather the negative, positive, and zero biases that are found across subperiods in the data. This task is taken up in Frydman and Goldberg (2007) and Frydman, Goldberg, and Kozlova (2013a), where we find that risk considerations, rather than irrationality, go a long way toward explaining the negative and positive biases for the three major currency markets.

In section 4, I present evidence that risk considerations also help to explain the finding that the size of the bias tends to be larger in developed countries. This implication emerges from an alternative risk-premium model developed in Frydman and Goldberg (2007, 2013b). The model uses endogenous prospect theory and imperfect knowledge economics (IKE) to represent individuals' risk preferences and forecasting behavior, respectively.[8] The model also builds on Keynes's (1936) insight that in assessing the riskiness of their speculative positions, market participants look to the gap between an asset price and their perceptions of its benchmark value. Bulls, who hold long positions, tend to raise their forecasts of the risk as this gap grows, whereas bears, who hold short positions, tend to respond in opposite fashion.

I show that a new IKE risk-premium model implies that currency markets that are characterized by more persistent exchange-rate swings away from and back toward perceived benchmark values are also characterized by greater average absolute forward-rate biases. Consequently, if developed countries were characterized by more persistent exchange-rate swings, the model would also provide an explanation of the finding that developed countries are characterized by a larger average bias.

To test these predictions, I make use of several measures of the persistence of currency swings: the average deviation of the exchange rate from its benchmark value over the sample, the width of bands from estimating a threshold cointegration model, and the half-life of deviations from the benchmark. Regardless of which of

[7] As Karl Popper put it, "quite apart from the fact that we do not know the future, the future is objectively not fixed. The future is open: objectively open" (Popper, 1990, p. 18).

[8] Endogenous prospect theory extends Kahneman and Tversky's (1979) prospect theory to allow for heterogeneous expectations and imperfect knowledge in asset-market models. IKE is an alternative approach to formal analysis that enables economists to recognize that the process underpinning market outcomes is to some extent open. Endogenous prospect theory and IKE are developed in Frydman and Goldberg (2007, 2008).

these measures is used, I find a strong positive correlation in the group of 52 counties between the degree of persistence of currency swings and the magnitude of forward-rate bias. I also find that developed countries are characterized by exchange-rate swings that are almost twice as persistent as those for emerging economies.

2 The Peril of Ignoring Structural Change

The forward discount anomaly is based on a regression of the actual future change in the spot exchange rate on the forward discount:

$$s_{t+1} - s_t = \alpha + \beta(f_{t/t+1} - s_t) + \varepsilon_{t+1} \tag{2.1}$$

where $\varepsilon_{t+1} = \triangle s_{t+1} - \triangle \hat{s}_{t+1}$ is the forecast error, $\triangle \hat{s}_{t+1}$ is the expected change in the future exchange rate, $fp_t = f_{t/t+1} - s_t$ is the forward premium, and $\triangle s_{t+1} = s_{t+1} - s_t$ is the future change in the spot exchange rate. If investors are assumed to be risk neutral and their expectations are portrayed with REH, then the forward rate should be an unbiased predictor of the future spot rate, that is $\alpha = 0$, $\beta = 1$, and ε_{t+1} is a mean-zero white noise process.

The forward rate unbiasedness hypothesis (FRUH) has been rejected by Bilson (1981), Fama (1984) and many other researchers who have examined a wide range of developed-country currency markets and estimated the BF regression over the entire sample. Most of these studies seem to agree on the direction of the bias. Indeed, in reviewing the literature, Froot and Thaler (1990) state that the average point estimate of β in 75 published articles is -0.88, implying predictable profits from betting against the forward rate predictions.

I reproduce this finding in Table 2.1 for the sample of 20 developed countries. Equation (2.1) is estimated by ordinary least squares (OLS) with Newey-West robust standard errors in order to correct for possible heteroskedasticity and serial correlation in the errors. The monthly data on the spot and forward rates for most countries are taken from World Market Reuters (WMR) and Bloomberg series. The data on Eurocurrency interest rates come from Financial Times and DRIFACTS database. The sample period for industrial countries spans from January, 1979 through May, 2011.[9]

Table 2.1 provides evidence that the forward rate is a negatively biased predictor of the future changes in the spot exchange rate for most developed countries' currencies – the estimated slope coefficients are considerably less than one and mostly negative. Greece is a lone exception with a statistically significant positive estimate of the slope coefficient. Denmark, Italy, Ireland and Spain also have positive estimates, but these are not statistically significant.

In Table 2.2, I estimate the BF regression for 32 developing countries. The sample size for these economies is constrained by the data availability and only covers the period from the late 1990s through 2011. The figures in Table 2.2 also provide evidence of a negative forward bias. But, like other studies, I find that the bias in less developed countries tends to be smaller in size. The beta estimates are less than one, but mostly positive for 22 out of 32 countries. Russia, the Philippines, Thailand and Colombia have large positive coefficients, while India, South Africa, and Chile have large negative estimates, but only a few of these figures are statistically significant. Taken at face value, I find that most developing countries have slope coefficients that are not significantly different from zero, while others have slope coefficients that are insignificantly different from one.

The overall pattern of findings implies that there is a tendency for a negative forward bias to be more pronounced for industrial than emerging market economies. This is consistent with the result reported by Bansal and Dahlquist (2000) and Frankel and Poonawala (2010). These studies together with Frankel and Chinn (1993) also estimate equation (2.1) using pooled regression technique. I will look at pooled regression estimates in section 3.

Researchers have concluded from this evidence that the forward rate is a biased predictor of the future change in the spot rate. They have developed a variety of risk premium models based on the rational expectations

[9] Detailed description of data samples and the list of countries under study can be found in Appendix A.

hypothesis (REH) to account for "supposedly" negative bias. Fama (1984) shows that in order for these models to account for the negative slope coefficient, the risk premium needs not only to be time-varying, but highly variable. However, empirical studies generally find that REH models do not produce nearly enough variation in the premium without implausibly large estimates of the degree of risk aversion.[10]

The failure of canonical risk-premium models has led many researchers to appeal to behavioral considerations to develop models in which irrational speculators could earn profits by betting against the forward rate, but choose not to do so because of forecasting biases or technical trading. But it is such efforts, not the profit-seeking motive in currency markets that should be questioned.

Consider that the foreign-exchange market is the largest, fastest-growing financial market in the world. Foreign exchange daily trading volume is now estimated to be close to $4 trillion, which is 50 times greater in volume than trade in real goods and services. The stakes in this market, as in any other large asset market, are extremely high. Financial institutions, which hire many of the participants who move the markets, pay large sums of money in order to attract the best and the brightest. Is it really possible that these individuals can make money by following a rule as simple as betting against the forward rate, and that they are either unaware of this opportunity or fail to exploit it?

2.1 Imperfect Knowledge and Structural Instability

In fact, currency returns in the foreign exchange market do not unfold in accordance with a pre-specified mechanical rule. The knowledge that underpins the market's forecast grows. Popper (1957) pointed out that if knowledge grows, then there is no way for any human being to successfully predict the future, since that would require him to know "today" that which he will only learn, discover, and know "tomorrow". Hence, as market participants' knowledge grows, they would revise their forecasting strategies at least intermittently.

Frydman and Goldberg (2013a) show how arguments in Popper (1982, 1990) provide a theoretical foundation for the proposition in their IKE model that market participants nor economists have perfect knowledge and full understanding of the true model of the economy. Agents test their models and update expectations functions as new information becomes available. Such revisions of individuals' forecasting strategies may occur due to changes in a country's institutions, political, economic and policy environments, technological shocks to productivity, and other shifts in social or psychological factors.

Since the social context also changes in ways that cannot be fully foreseen, revisions will involve not just different betas but also different variables.[11] Mangee (2013) and Sullivan (2013) show that in real-world markets, the way fundamentals, psychology, and social context matter changes over time. There are sub-periods during which the relationship is relatively stable, but eventually knowledge or some other facet of the process changes at points in time and in ways that do not conform to a mechanical rule, leading to a new relationship. This implies that in the foreign exchange market not only are the fundamental processes unstable, but different sets of fundamentals matter in different subperiods.

Thus, the correlations between the future change in the exchange rate and the forward premium will depend on the fundamental variables that agents use to forecast and the way they interpret this information when forming their expectations about future returns, that is it will depend on their forecasting strategies. Market participants sometimes revise their forecasting strategies as new information on fundamentals becomes available, and, when they do, they cause the correlations in the data to shift.

To see this, the projection of the risk premium, $\hat{rp}_{t/t+1} = \triangle \hat{s}_{t/t+1} - fp_t$, on the forward premium, fp_t, can be written as follows:

$$E(r\hat{p}_{t/t+1}, fp_t) = cov(\triangle \hat{s}_{t/t+1}, fp_t) - var(fp_t) \tag{2.2}$$

From equation (2.2) it can be seen that revisions in forecasting strategies will lead to shifts in the relationship

[10]See Frankel and Engel (1984), Domowitz and Hakkio (1985), Engel (1996) and Mark (1988).
[11]See Goldberg and Frydman (1996) for more details.

between market participants' expectations of $\triangle \hat{s}_{t/t+1}$ and the causal variables that enter into their forecasting strategies. This in turn, will cause the correlations in the data to shift. So we would not expect the slope coefficient in the BF regression to be constant over time.

Consequently, empirical studies aimed at explaining the forward discount puzzle should allow for correlations in the data to be temporarily unstable. Ignoring structural change may obscure empirical results. Indeed, Baillie and Bollerslev (2000), Maynard and Phillips (2001), and some other studies have recognized that when structural breaks are ignored or high persistence in the data is not taken into account, spuriously unfavorable empirical results may be obtained. Frydman and Goldberg (2007) and many other studies that have used developed countries' data show that the slope coefficient in the BF regression is temporarily unstable (see Chinn, 2006; Flood and Rose, 2002; Sakoulis and Zivot, 2000; Lewis, 1995; and Engel, 2011). They find that the coefficient can sometimes be negative, sometimes positive and insignificantly different from zero or one.

2.2 Piece-Wise Linear Approximation

Under IKE, market participants typically revise their forecasting strategies in a guardedly moderate way. This means that unless individuals have specific reasons to change their forecasting strategies, they will adhere to their existing strategy or only alter it in a gradual fashion. In other words, the impact of these revisions on forecasts does not outweigh the influence stemming from trends in fundamentals themselves. This implies that there are stretches of time when traders leave their forecasting rules unaltered or slightly modified, so that the relationship between the forward premium and the risk premium stays relatively constant within the regimes.

To allow for such type of structural instability in the analysis, the relationship between excess returns and the forward premium is approximated as piece-wise linear, that is, there are long stretches of time (the linear pieces) during which correlations are stable, but across linear pieces the correlations are different. In each of the identified regimes, the relationship between the forward premium and realized returns is estimated with constant parameters.

If a market participant does have reasons to suspect or anticipate a genuine change, he cannot be sure about his beliefs, let alone about the precise date or nature of the change. Therefore, the IKE model fully pre-specifies neither when the trends in fundamentals will change nor when market participants will revise their forecasting strategies. This leads us to consider structural change tests that are based on recursive estimation in order to determine de facto structural breaks endogenously, rather than imposing de jure structural breaks a priori.

2.2.1 Detecting Points of Instability

In this study, I utilize several different structural break tests to formally investigate the stability of the forward bias. First, the CUSUM of Squares test (CUSQ) together with the one step Chow test - which are both based on recursive estimation - are employed to test for break points sequentially. Second, the multiple structural breaks test by Kejriwal and Perron (2010), hereafter KP, - which uses F statistics - is performed to determine multiple break points simultaneously.

The CUSUM of Squares test is designed for a single break, so the sequential procedure of testing for regime shifts at unknown times is applied. First, I seek to identify one structural break. I estimate the one-step Chow test up to the point where the CUSQ test crosses its critical value and deduce from the test the corresponding estimated break date. Next, with the sample split into two subperiods, I test for the presence of a possible additional break by running the CUSQ test for each of the subsamples. If the CUSQ test crosses its critical value, the one-step Chow test is applied in a similar fashion to select the second breakpoint. The procedure is repeated in this way until no further break date appears to be significant from the CUSQ test.

To check the results for robustness, I also apply the KP test. Kejriwal and Perron (2010) propose a dynamic programming approach that not only enables consistent estimation of multiple structural changes but also allows for both I(0) and I(1) regressors to be present in the model. Their model evaluates which break achieves a global minimization of the overall sum of squared errors (SSE) and then sequentially examines the optimal breakpoint by solving the following problem:

$$SSE(\{T_{m,T}\}) = \min_{mh \leq j \leqslant T-h} [SSE(\{T_{m-1,j}\}) + SSE(\{T_{j+1,T}\})] \tag{2.3}$$

where h is the minimum distance between each break, m is the number of breaks, T is the total number of observations, and SSE is the sum of squared errors associated with the optimal partition containing m breaks using first T observations. In fact, the test is equivalent to the application of $(m+1)$ tests of the null hypothesis of no structural change versus the alternative hypothesis of a single change.

Applying the KP procedure to the Bilson-Fama regression gives us:

$$\Delta s_{t+1} = \alpha_j + \beta(f_{t/t+1} - s_t) + \varepsilon_{t+1}, \qquad t = T_{j-1} + 1, ..., T_j \tag{2.4}$$

where $j = 1, ..., m+1, T_{0=0}, T_{m+1} = T$ are the unknown breakpoints. The optimal breakpoints are estimated by:

$$(\widehat{T}_1, ..., \widehat{T}_m) = \arg\min S_t(T_1, ..., T_m) \tag{2.5}$$

2.2.2 Interpreting the Results

Tables 2.3-2.4 and figures 2.1-2.2 report the results of structural break analysis. The results reveal that the relationship between the forward premium and excess returns is temporarily unstable. For both developed and developing country groups, there are multiple structural breaks in each currency market. For most of the studied currencies, the structural break in the exchange rate is detected either on or before the date of a specific policy shift, economic event or change in the exchange rate arrangement.

By comparing the results from two structural break tests, I establish that the break dates from the KP test are similar to what have been detected by the CUSQ sequential procedure. However, several local breakpoints at the beginning and the end of the sample, as well as closely located structural breaks, have not been detected by the KP procedure due to its trimming parameter. This may indicate the robustness of the empirically estimated structural break results. Therefore, with no considerable differences arising from the results, I proceed using the breakpoints obtained by the CUSQ test combined with the one-step Chow test methodology.

Tables 2.5-2.6 present the results of estimating the BF regression for industrial and emerging countries' currency markets, taking into account structural breaks. The full sample is partitioned at each of the multiple breakpoints, and the hypothesis of forward rate unbiasedness is reevaluated for each regime of relative parameter stability.

Interestingly, once the structural breaks are accounted for, the forward discount coefficients behave differently from the original Bilson-Fama regression without breaks. The slope estimates for the subsample BF regressions exhibit large fluctuations from period to period. Inspection of Tables 2.5 and 2.6 reveals that forward premium biases are generally persistent and switch sign occasionally. Specifically, slope coefficients are found to be negative in some regimes, while positive or insignificantly different from zero or one in others across industrial and less developed countries.

The significant estimates of the beta slope coefficient in different subperiods of relative parameter stability and their wide range indicate that the restriction of parameters to be constant in conventional regression models is inappropriate and misleading. These findings confirm those of Frydman and Goldberg (2007) implying that there exists no stable systematic correlation between future excess returns and the forward premium.

Given the evidence that beta is not negative, what needs to be explained is not the statistically significant negative bias of the forward premium, but rather why the correlations between the forward premium and excess returns are negative during some stretches of time, but positive and either less than or greater than one during others. Such high instability of the forward discount predictions implies that an easy forecasting rule like betting against the forward premium cannot generate constant profits in a world of imperfect knowledge. It can be profitable during some periods, but deliver losses during others. No one can foresee when these temporary correlations will occur or disappear, whether they will be positive or negative and how long they will last.

The key question becomes: how do we explain the observed variation in the beta? Risk premium considerations, rather than irrationality, go a long way toward explaining negative and positive biases. The evidence of the risk premium being a major source of the forward discount bias has been widely documented in survey-based studies. Cavaglia et al. (1994) and Verschoor and Wolff (2001) find that the risk premium for some developed countries' currency markets is significantly different from zero, and varies substantially over time. Further evidence provided by Frankel and Chinn (1993) and Marston (1994) shows that risk premiums are strongly related to interest differentials.

Frydman, Goldberg, and Kozlova (2013a) document that risk premiums are large and variable and play an even more important role in explaining the forward premium bias if one accounts for the structural instability. In this work, we show that risk explains roughly half of the bias in most sub-periods in Japanese yen, German mark, and British pound currency markets. Frydman and Goldberg (2007) and Frydman, Goldberg, and Stillwagon (2013b) demonstrate that the IKE risk-premium model can account for fluctuations in survey-based measures of the risk premium in all three markets. This empirical evidence indicates that variation in risk over time is essential for understanding movements in currency returns in the foreign exchange market.

3 Greater Bias in Developed Countries

Having estimated large negative biases for developed countries, it is natural to ask whether developing countries are also characterized by such an "anomaly." Recent empirical studies that extend the analysis of forward-rate biasedness to include emerging market economies find that they do. However, their results, which are based on pooled regression analysis that continue to ignore the problem of structural change, suggest that the bias tends to be smaller. Bansal and Dahlquist (2000) were the first ones to document that the negative bias is less pronounced for developing than for developed countries. Another study by Frankel and Poonawala (2010) cannot reject the FRUH in many emerging markets, concluding that the forward premium seems to be a less biased predictor of the future change in the exchange rate for these countries. Many other researchers like Chinn (2006) and Ito and Chinn (2007) find similar results, providing extra evidence that, unlike the major currencies, which are marked by a large negative slope coefficient, the forward-rate biasedness is not so severe in developing countries.

Table 3.1 reports pooled regression for the sample of developed and developing countries. In the first sample I have developed and developing country groups over the period from 1997 to 2012. The second sample includes high-income, upper middle-income and lower middle-income country groups over the same sample period. [12]

First, I restrict the intercept and slope coefficient to be the same across different countries within a group. The slope estimate for the developed economies group is -1.45 and statistically significant at the 5% level, while for the developing economies group it is 0.26 and insignificantly different from zero. I get a similar pattern of estimates using the second sample (see Table 3.1).

In order to allow each country to have its own specific intercept, I include fixed effects in the regression. When the fixed effects model is estimated for developed and developing country groups separately, I find even more pronounced differences between them. The slope coefficient for developed countries becomes more negative and statistically significant (-1.82), while developing countries' slope coefficient is still positive and statistically significant at the 1% level (0.057). The slope coefficient estimate for the high-income country group is negative, but insignificantly different from zero (-0.009), while the slope coefficients for the upper and lower middle-income country groups are both positive and statistically significant at the 1% level (0.70 and 0.35, respectively).

Overall, like other studies I find that the negative bias for developed countries as a group is larger in size than for developing countries. But, given the structural change results, this finding has little meaning. What does make sense is to ask whether on average the size of the positive and negative biases is greater in developed than in developing countries. This would be the case if speculating in developed country markets were riskier

[12]Detailed description of these country groupings can be found in Appendix B.

than in developing countries.

I average the absolute values of estimates of the slope coefficient and the implied forward bias from the distinct linear pieces of the data for each country. Table 3.2 provides evidence that developed countries are characterized by a greater average absolute bias than developing countries. Although countries in both groups are characterized by both positive and negative biases over the sample periods, the size of these biases tends to be much larger for developed countries. Comparing the results in Table 3.2 with those in Tables 3.1, 2.6, and 2.5 reveals that this tendency is more pronounced than the tendency that I and other researchers find based on pooled regressions. These important differences between advanced and emerging economies imply that the relationship between the forward premium and excess returns varies across countries and calls for theoretical explanations.

4 Forward-Rate Bias and the Persistence of Currency Swings

I now present evidence that the IKE risk-premium model can account for this tendency. Like with other risk premium models, an individual's decision on whether to hold a long or short position in foreign exchange and, if so, how large the stake should be, depends on her forecast of the future return and her assessment of the riskiness of doing so. In representing how an individual's forecasts of the return and risk influence her utility, the model relies on endogenous prospect theory. This alternative specification of preferences builds on Kahneman and Tversky (1979) and Tversky and Kahneman (1992) and assumes that an individual's degree of loss aversion increases as the size of her open position in the market raises.[13] With "endogenous loss aversion," a market participant will take a finite speculative position in foreign exchange only if she expects a positive excess return—a premium—to compensate her for her extra sensitivity to the potential losses.[14] This premium depends on an individual's point forecast of the potential loss that she might incur from an open position in the market.

In order to represent the point forecasts for bulls and bears, who hold long and short positions, respectively, the model appeals to an insight from Keynes (1936) that what matters for assessing risk in financial markets is the divergence between an asset price and its perceived historical benchmark value. Although asset prices have a tendency to move persistently away from benchmark values for long stretches of time, they eventually undergo, at unpredictable moments, sustained movements back toward these values. Keynes recognized that market participants are aware of this behavior and use it in their attempt to assess the riskiness of their open positions.[15]

The IKE model assumes that bulls tend to raise their point forecast of the potential unit loss as the gap grows, whereas bears, who hold short positions, tend to respond in opposite fashion. In equilibrium, the market's risk premium depends on the risk premium of the bulls minus the risk premium of the bears[16].

The model implies that any stretch of time in which market participants' interpretations of the gap in forecasting potential losses remained unchanged would be characterized by a stable and positive relationship between the market risk premium and the gap. However, the model recognizes that market participants will revise their forecasting strategies, at least from time to time. For example, we would expect that the importance participants attach to the gap when it is historically large is greater than when it is historically small.[17] Such revisions lead to structural change in the relationship between the market risk premium and measures of the

[13]An individual is loss averse if her disutility from losses is greater than her utility from gains of the same magnitude.

[14]Behavioral economists refer to an individual's decision to hold a finite speculative position despite the expectation of an excess return as "limits to arbitrage." Modeling such limits is considered to be one of the pillars of behavioral finance. See Barberis and Thaler (2001). Endogenous prospect theory provides a way to do so without abandoning any of the experimental findings of Kahneman and Tversky (1979) and others. See Frydman and Goldberg (2007).

[15]As Keynes put it in discussing the bond market, "[u]nless reasons are believed to exist why future experience will be very different from past experience, a ...rate of interest [much lower than the benchmark rate], leaves more to fear than to hope, and offers, at the same time, a running yield which is only sufficient to offset a very small measure of fear [of capital loss] (Keynes, 1936, p.202)."

[16]A detailed outline of the model can be found in Appendix C.

[17]Frydman and Goldberg (2007, 2011) present evidence of such non-linear behavior in the survey measures of the market risk premium.

gap. The equation for the market risk premium that is implied by the model can be expressed as follows:

$$\hat{rp}_{t/t+1} = \alpha + \sigma_t \hat{gap}_t + \varepsilon_t \tag{4.1}$$

where $\hat{gap}_{t/t+1} = s_t - \hat{s}_t^{BM}$ denotes the gap between the current exchange rate, s_t, and the aggregate of participants' estimate of a historical benchmark value, $\hat{s}_t^{BM}$; σ_t is sensitivity of their premiums to the gap; α depends on the international financial position of the domestic country relative to the foreign country, IFP; and ε_t is mean zero error.

We can see from equation (4.1) that the persistence of $\hat{rp}_{t/t+1}$ depends on the persistence of the gap. The IKE model predicts that the time periods that are characterized by persistent swings in exchange rates in one direction should also be characterized by persistent swings in the market premium in the same direction.

Researchers have found that swings in U.S. dollar exchange rates relative to benchmark values based on purchasing power parity (PPP) are highly persistent. Most studies are unable to reject the hypothesis that bi-lateral real rates are highly persistent integrated of order one, or I(1), processes.[18] I am interested in the connection between the persistence of gap, and thus the risk premium, with forward-rate bias as measured by the BF regression. To this end, I approximate the risk premium process as an ARMA(1,1) process:

$$rp_t = \rho rp_{t-1} + \varrho v_{t-1} + v_t \tag{4.2}$$

where ρ and ϱ are autocorrelation coefficients that are less than unity, and v_t is a white noise sequence with mean zero and variance σ_v^2, which is uncorrelated with ε_t. The forward premium is assumed to be generated by an AR(1) process:

$$fp_t = \theta fp_{t-1} + e_t \tag{4.3}$$

where θ is an autocorrelation coefficient, which is less than one, and e_t is i.i.d. error term. These assumptions are consistent with the theoretical model since they allow for a high persistence and a large noise component in the risk premium. Large roots ρ and θ that are close to unity imply highly persistent processes.

The slope coefficient in the BF regression is given by:

$$\beta = \frac{cov_t(\Delta s_{t+1}, fp_t)}{var(fp_t)} \tag{4.4}$$

Making use of $s_{t+1} = \Delta\widehat{s}_{t+1} + \epsilon_{t+1}$ and the expression for the risk premium $\widehat{rp}_{t/t+1} = \Delta\widehat{s}_{t+1} - fp_t$, the slope coefficient β can be written as:

$$\beta = 1 - \frac{cov_t(rp_t, fp_t)}{var(fp_t)} + \frac{cov_t(\varepsilon_t, fp_t)}{var(fp_t)} \tag{4.5}$$

That is, the bias in the forward premium can arise either due to correlations between the time-varying risk premium and the forward premium or due to systematic correlations between expectational errors and the forward premium. The absolute size of the bias would be:

$$|1-\beta| = \left| \frac{cov_t(rp_t, fp_t)}{var(fp_t)} - \frac{cov_t(\varepsilon_t, fp_t)}{var(fp_t)} \right| \tag{4.6}$$

Since I am interested in the risk premium explanation of the forward-rate biasedness, the modeling strategy focuses on the covariance term between the forward premium and the risk premium only.

Substituting these statistical formulations for the risk premium and the forward premium given by equations

[18] But, when researchers look for persistence in the first-differences of nominal and real rates using multivariate procedures, they typically find it, suggesting that these variables are better characterized as near-I(2) variables. See for example the I(2) CVAR analysis in Johansen et al. (2010). Frydman et al. (2013) show that such near-I(2) behavior can be explained by Frydman and Goldberg's (2007, 2013a) IKE model of currency swings and risk.

(4.2) and (4.3) into equation (4.6), I obtain an expression for the magnitude of the forward-rate bias:

$$|1-\beta| = \left| \frac{cov_t(\rho rp_{t-1} + \varrho v_{t-1} + v_t, \theta fp_{t-1} + e_t)}{var(fp_t)} \right| \tag{4.7}$$

Given that the v_t and e_t are white noise errors, which are uncorrelated with the information set, can be rewritten as follows:

$$|1-\beta| = \rho\theta \left| \frac{cov_t(rp_{t-1}, fp_{t-1})}{var(fp_t)} \right| \tag{4.8}$$

where we recall that a slope coefficient greater than (less than) unity implies positive (negative) bias.

Equation (4.8) shows that according to the IKE model, stretches of time that are characterized by more persistent swings from benchmark values (which, according to the model, leads to the swings in the risk premium) and more persistent fp_t will also be characterized by the forward bias that is larger in size, regardless of whether it is positive or negative.

This proposition is also supported by empirical literature that is based on Monte Carlo simulations. It suggests that the magnitude of the correlation coefficient between two series is increasing in their levels of persistence. For instance, Granger and Newbold (1974) show by simulating ARMA models that the regression of two I(1) processes produces significant slope coefficients even for two unrelated variables. Even more significant correlations are found between combinations of series with higher orders of integration ($\geq$I(1)), as shown in Nelson and Kang (1984) and Durlauf and Phillips (1988).

The intuition behind these findings can be traced to the results in Yule (1926). He pointed out that the properties of the sample correlation coefficient of two random variables are related to the shape of the frequency distribution of the correlation coefficient of the two series. More precisely, Yule (1926) simulated the frequency distribution of the empirical correlation coefficient for various orders of integrated independent time series. He found that if two series are stationary, the frequency distribution of the correlation coefficient will look like normal distribution. If the two processes are non-stationary I(1) processes, the frequency distribution of the correlation coefficient will be semi-ellipse, whereas if the two processes are non-stationary I(2) processes, the frequency distribution has a U shape with values of -1 and +1 to be more likely to occur. Using Monte Carlo simulations, I replicate Yule's (1926) initial results for a sample size of 100 observations, but using 1000 replications (see 4.1). It follows that the higher the persistence of the series, the more likely the correlation coefficient between them would be either 1 or -1 (perfectly correlated).

Consequently, if developed countries were characterized by more persistent exchange-rate swings, and thus risk premiums, the model would provide an explanation of our finding that developed countries are characterized by a larger average bias.

The intuition behind it is that emerging economies are far more likely to be characterized by managed floating exchange rate regimes that generally lead to less persistent departures from benchmark levels. Hard pegs, currency boards, target zones, and managed floating exchange rate regimes are meant to reduce or even eliminate currency risk. Moreover, less pronounced deviations from benchmark values would be more likely in the case of developing countries as a result of their tendency to apply capital controls. This is because exchange rate controls have the effect of reducing speculation against the currency, thereby generating lower exchange rate volatility. The opposite is obviously true for developed countries, which are commonly known as free floaters. Sure enough, we would be more likely to find persistent deviations from benchmark values in countries with a high degree of foreign exchange rate speculation and capital movements.

5 Measuring the Persistence of Exchange Rate Swings

5.1 Average Deviations from Historical Benchmarks

5.1.1 Specification of Historical Benchmark

One way of modeling the persistence of currency swings is by calculating the average deviation of the exchange rate from its benchmark value over the sample. The intuition behind it is as follows. Since a less persistent variable have a tendency to quickly return to its long-run equilibrium mean, it will not drift too far away from its mean value. This implies that a low persistent process will have small average deviations from its benchmark value. By contrast, a more persistent process takes a long time to return to the mean. Thus, the series will trend in one direction or the other for longer periods of time, resulting in large average deviations from its historical benchmark value.

To develop an empirical measure of the persistence of the risk premium that is consistent with the theoretical model of risk, it is necessary to construct a measure of the gap between current exchange rate and its long-run benchmark value. By a historical benchmark I mean a stable and slowly moving rate that provides a long run anchor for exchange rates.

The specification of this benchmark exchange rate and the deviations from it depend on one's beliefs about what variables affect this fundamental rate. Thus, market participants might have different views of the benchmark depending on what models or information they use. One benchmark level that is often utilized in open economy macroeconomics is the purchasing power parity (PPP) exchange rate. PPP estimates are important for practical purposes such as determining the degree of misalignment of the nominal exchange rate and the appropriate policy response, the setting of the exchange rate parities, and the international comparison of national income levels.

Modeling the benchmark rate as PPP might not be a bad approximation between developed countries given that their productivity growth rates and inflation rates have been reasonably similar. However, in the case of developing countries, one would not expect PPP to hold, due to several reasons. It is a well-known fact that developing countries are characterized by more government interventions and trade restrictions than their developed counterparts. Furthermore, the economic structure of these countries tends to be diverse, with changes occurring more frequently than in developed countries.

Another important aspect about emerging market economies that has to be taken into account is the Balassa-Samuelson (BS) effect (due to Balassa, 1964 and Samelson, 1964). It states that there is a tendency for countries with higher productivity in the tradable sector to have higher price levels. One of the implications of the BS hypothesis is that countries with rapidly expanding economies should tend to have more rapidly appreciating real exchange rates. Froot and Rogoff (1996) and Obstfeld (1993) along with other researchers show that the productivity growth differential between tradables and nontradables can lead to a time trend in the real exchange rate for emerging countries. It therefore follows that deviations from PPP would not be an appropriate measure of the persistence of exchange rate swings in less developed currency markets.

Thus, in order to model long-run deviations from the fundamental exchange rate in developing countries, I need to include some measure of productivity growth rate differentials. I expect that including a time trend could help to account for the impact that these differentials have on the exchange rate, as noted by Balassa (1964). The estimation equation becomes:

$$q_{it} = \mu_i + \theta_i t + \epsilon_i \tag{5.1}$$

where t is the time trend. The equation for the real exchange rate is given by: $q_{it} = s_t + P_t^* - P_t$,where s_t stands for a nominal exchange rate and P_t^* and P_t are foreign and domestic price levels.

I calculate the persistence of exchange rate swings as average deviations from benchmark values for developed and developing countries by taking the difference between the actual and estimated real exchange rate:

$$\frac{1}{T}\sum(q_{it}-\widehat{q}_{it}) = AveDEV \tag{5.2}$$

In this way, I are able to pin down the center around which the exchange rate tends to fluctuate over the period under consideration. The average deviations from time trend would provide a measure of the persistence of the exchange rate swing.

5.1.2 Empirical Results

Estimation of the equation (5.1) for the full sample period for each country yields the results provided in Table 5.1 and depicted in figures 5.1-5.2. As expected, I find significant time trends for most developing countries. However, in the case of developed countries only a few time trends are significant at the 5% level or better. Table 5.1, which also calculates average deviations from benchmark for both groups of countries, shows that the estimates are hardly of the same magnitude. While examining the size of the gap for individual countries, I find evidence of a large variation in the average deviations across developing countries: the estimates range from 2.48% for Malaysia to 19.57% for Russia. There are about ten currencies in the sample with deviations from benchmark values that exceed 10%. For the other developing currencies most gaps lie between 5 and 10% (see figure 5.3). In contrast, developed countries tend to have a less divergent pattern of exchange rate swings with the majority of deviations (gaps) ranging between 10% and 15%.

The last row of Table 5.1 provides the estimate of the average size of the gap calculated for developed and developing countries as separate groups. It shows that on average the persistence of the exchange rate swings in advanced countries are almost twice as large as the persistence of swings in emerging countries, which is consistent with theoretical model's predictions.

To test whether the size of the gap for developing countries is statistically different from that of developed economies, I make use of a χ^2 statistic. As shown by Porteous (1987), this is valid if the two are independently distributed. The statistics for these two country groups is equal to 20.8 and statistically significant at the 1% level.

5.2 Threshold Cointegration Approach to Measuring the Persistence of Swings

5.2.1 A Direct Link between the IKE Model of Risk and Threshold Cointegration Model

Another way of modeling the persistence of exchange rate swings is by using a threshold cointegration model. Threshold cointegration methodology requires the estimation of discrete thresholds separating a central regime, in which almost no adjustment to equilibrium takes place, from outer regimes, in which strong equilibrating forces appear. The threshold cointegration maintains that the error correction does not occur within a certain band, but only when the system is far away from the equilibrium, exceeding a given threshold.

Such adjustment is useful in explaining the behavior of market participants in the foreign exchange market. Under IKE, it is reasonable to suppose that, if departures from benchmark values were to continue to grow, a threshold would be eventually reached beyond which the gap would be so large that bulls become much more concerned about their capital losses. In this case, the aggregate uncertainty premium would be large and bulls decide to reduce their long positions. That is when the reversion to the benchmark occurs.

The threshold cointegration captures such a nonlinear behavior of the real exchange rate: a mean reverting dynamic movement of the exchange rate can be expected after exceeding a given band. According to the IKE risk-premium model, this nonlinearity may arise from the heterogeneity of opinion in the foreign exchange market concerning the level of the exchange rate gap: as the nominal exchange rate takes on more extreme values, a great degree of consensus develops concerning the appropriate direction of exchange rate movements, and traders act accordingly.

This new model of risk is capable of generating very large and persistent transitory deviations from historical benchmarks based on the interaction of bulls and bears who have different views concerning the appropriate level of the macroeconomic fundamentals and the level of an equilibrium exchange rate. They also differ in their interpretation of the economic data on fundamentals and the underlying model of the exchange rate which they employ. These differences lead both bulls and bears to different predictions of the future exchange rate and, thus, to their disagreement on the direction of the exchange rate.

Note that the IKE risk-premium model endogenously generates threshold behavior in the spot exchange rate. Suppose that the spot exchange rate at a given date is somewhere within the band defined by two thresholds of the gap. Within the band, bulls and bears continue to pursue their forecasting strategies: bulls are betting on the exchange rate appreciation and bears will bet on the exchange rate depreciation. Nonetheless, both bulls and bears forecast potential losses that they would incur if the price were to move against them. Depending which side of the market is larger the exchange rate will move accordingly. This trend in the exchange rate will continue as long as bulls and bears stay on their side of the market and alter their forecast in a guardedly moderate way. This implies that within a band, the exchange rate would be characterized by very persistent movements (near unit root behavior).

However, once the gap crosses some threshold level beyond which individuals become more concerned about their potential losses, they would revise their forecasting strategies in a non-routine way and forecast that the exchange rate will reverse. Thus, whenever the exchange rate is outside of the band, some bulls would become more bearish in predicting the direction of movement and the exchange rate will revert toward the band, and so the tendency would be to come back inside the band.

These features of the IKE model motivate the use of the threshold cointegration model in the context of an explicit band as the measure of the persistence of the exchange rate swing. Since the threshold cointegration model implies that speculative activity will push the deviations to the edges of the band, rather than to its center, we would expect to find wider bands for developed countries, because they are characterized by higher speculative activities than developing countries. Testable implications can be formulated as follows:

1. The no-arbitrage band is larger for developed than developing countries.
2. The thresholds are likely to be asymmetric around zero.

5.2.2 Threshold Cointegration Estimation

The no-arbitrage bands are estimated using a Smooth Transition Autoregressive model (STAR) as described by Teräsvirta (1994). It is particularly attractive in the present context, as the strength of the equilibrating force is increasing in the (absolute) magnitude of the degree of disequilibrium, relaxing the assumption of constant speed of adjustment.

When the STAR model is applied to the real exchange rate (q_t), the general specification for the real exchange rate series can be written as follows:

$$q_t = \alpha + \sum_{j=1}^{p} \zeta_j q_{t-j} + \alpha^* + \left(\sum_{j=1}^{p} \zeta_j^* q_{t-j} \right) \phi[\theta : q_{t-d} - \mu] + u_t \tag{5.3}$$

where α and α^* are regime constants, q_t is assumed to be a stationary process with equilibrium level μ, and u_t is independently, identically and normally distributed with mean zero and constant variance. d is the delay parameter, and $\phi[\theta : q_{t-d}]$ is a transition function which determines the degree of mean reversion and is itself governed by the parameter θ. In this model, nonlinearity arises through conditioning on lagged real exchange rates. The parameter q_{t-d} is the endogenous transition variable that represents the time necessary for the real exchange rate to start its reversion process in response to a shock.

The transition function, $\phi[\theta : q_{t-d}]$, is an exponential function as suggested by Granger and Terasvirta (1993):

$$\phi[\theta : q_{t-d}] = 1 - \exp[-\theta^2 (q_{t-d} - \mu)^2] \tag{5.4}$$

In this case, the model would be called an exponential STAR or ESTAR model. The exponential transition function is bounded by zero and unity, and has a U-shaped form.

When $q_{t-d} \to \infty$, its equilibrium value is $\phi[\theta : q_{t-d}] = 0$ and the model reverts to a standard linear AR(p) representation $q_t = \alpha + \sum_{j=1}^{p} \zeta_j q_{t-j} + u_t$. Conversely, for extreme deviations from equilibrium if $q_{t-d} \to -\infty$ I obtain $\phi[\theta : q_{t-d}] = 1$, and the model becomes a different AR(p) process, $q_t = \alpha + \alpha^* + \sum_{j=1}^{p} (\zeta_j + \zeta_j^*) q_{t-j} + u_t$. The transition between these two regimes is smooth, in that as $|q_{t-d}|$ increases in magnitude, the behavior of q_t becomes more dependent upon the starred coefficients' values.

I estimate the ESTAR model with two thresholds, which results in three regimes with differing autoregressive parameters for the real exchange rate. Each regime is defined based on the magnitudes of the threshold values for the lower and upper ranges of real exchange rates, θ_1 and θ_2. The AR(1) process within the band is allowed to be a random walk, but the hypothesis of efficient arbitrage implies that the AR(1) process outside the bands is stationary. If the thresholds were known, the model could be estimated by ordinary least squares applied separately to the inner regime and outer regime observations. But since the thresholds are not known, the model does a grid search over possible threshold combinations. It chooses the set of negative and positive values of thresholds that minimize the residual sum of squares. This estimation method is a type of constrained least squares, and yields estimates that are consistent (see Hansen, 1999; and Pasricha, 2008).

5.2.3 Discussion of the Results

Table 5.2 and figures 5.4-5.5 summarize the estimates of the ESTAR model using detrended real exchange rate series for each of the currency markets in the sample.[19] The $\theta_{1,2}$ estimates vary widely across countries, with the width of the band for some real exchange rates being much higher than others.[20] Their values generally support ESTAR model's adequacy, with $\theta_{1,2}$ for most series being clearly distinguishable from zero.

Based on empirical estimates, the behavior of real exchange rates can be summarized as follows. The developed countries, as expected, on average have wider threshold bands than emerging market economies, as well as more observations that lie within the thresholds. Switzerland, New Zealand and the Netherlands have the widest threshold bands that are close to 30%, while Norway and Finland have the narrowest bands that are below 10%.

Among developing countries, Brazil, Chile and Russia have the widest bands that exceed 20%, while Malaysia and Thailand have the narrowest bands that are below 5%. Latvia, Bahrain and Saudi Arabia also have narrow bands. Most developing countries have thresholds that are asymmetric around zero, with larger negative thresholds than positive ones. This finding can be explained by the fact that monetary authorities in developing countries might be more concerned and willing to intervene in the foreign exchange market when the currency is over-valuated rather than under-valuated.

The results suggest that, on average, developed countries can be characterized by wider middle regimes, where there is no cointegration due to the unit root behavior, and narrower outer regimes, where the real exchange rate reverts to its equilibrium with the speed of adjustment increasing in the magnitude of deviations. The threshold cointegration methodology, therefore, is able to capture the key features implied by the IKE risk-premium model.

5.3 Half-life of Deviations from Historical Benchmark

5.3.1 Exchange Rate Persistence and IKE

The last measure of the persistence of exchange rate swings is based on the half-life of deviations from benchmark values. It is defined as the number of periods that it takes for deviations from benchmark values to subside by one half in response to a unit shock in the level of the series. According to the IKE model, expectations of the future exchange rate, $\widehat{s}_{t/t+1}$, are the main driver of swings, which also implies corresponding swings in the nominal (s_t) and real (q_t) exchange rates. Then the time path for the real exchange rate can be expressed as segmented-trends processes:

[19] The benchmark value for detrended real exchange rates is zero.

[20] The width of the band from estimating ESTAR model is calculated in percentage terms.

$$q_t = q_{t-1} + \xi_t + \eta_t \tag{5.5}$$

$$\xi_t = \frac{\eta}{G}(\Delta\varphi_t + \varphi_{t-1}\mu^x) \tag{5.6}$$

where η_t is a mean-zero error term, φ_t stands for the weight individuals attach to different fundamentals when forming their forecasts of the future exchange rate, and μ^x denotes trends in fundamentals.

The IKE model of risk says that future changes in q_t will depend on the initial baseline drift, $\varphi_{t-1}\mu^x$. If $\varphi_{t-1}\mu^x > 0$ and individuals revise their forecasting strategies in a moderate way, the change in their forecasts will be positive leading to the persistent half-life deviations in q_t over the period. Revisions of forecasting strategies also lead to shifts in the drift. If revisions of strategies are guardedly moderate, the changes in the drift will be small and ξ_t will tend to take on values of the same sign resulting in more prolonged half-life deviations.

Thus, the IKE model implies high exchange rate persistence if revisions of forecasting strategies are sufficiently moderate during an upswing or a downswing, and the number of reversals is small compared to the total number of time periods. The testable hypothesis is that developed countries are more likely to exhibit such persistent half-life of deviations away from and towards long-run benchmark values than developing countries.

5.3.2 Half-Life Deviations Estimation

In this paper, I relate the half-life deviations to the modulus of the characteristic roots of the autoregressive polynomial. They are usually defined on the interval (-1, 1) and can be interpreted as a measure of the speed of adjustment. Let's say ρ_1 is the modulus of the largest root in the simple AR(1) :

$$q_t = c + \rho_1 q_{t-1} + \epsilon_t \tag{5.7}$$

$$\Delta q_{t+1} = -(1 - \rho_1)q_{t-1} + \epsilon_t \tag{5.8}$$

where $\alpha = -(1 - \rho_1)$ is the adjustment coefficient, which corresponds to an average adjustment time of $\frac{\ln(2)}{\ln(1-\alpha)}$ periods of deviations from the long-run equilibrium.

The above classification is applicable in a univariate model. However, some recent studies propose an alternative test procedure that has a better power than univariate tests. Juselius (2010) suggests measuring persistence by relating it to the number of (near) unit roots in the characteristic polynomial of a multivariate cointegrated vector (CVAR) model. Even though CVAR analysis provides a better account of the exchange rate persistence, it is not easy to measure the persistence level for a particular variable of interest under this analysis. In a p-dimensional CVAR model, the number of large roots in the characteristic polynomial is a function of a number of exogenous (common) stochastic trends, and thus, a large characteristic root cannot be directly associated with the variable in question, x_t, but rather a vector of variables. Therefore, I leave the CVAR analysis for future research.

5.3.3 Summary of Empirical Results

I start by testing all real exchange rates series for an order of integration using the standard augmented Dickey Fuller test (ADF). ADF test adds k first lagged differences of the real exchange rate to the equation (5.7) in order to allow for serial correlation:

$$q_t = c + \rho_1 q_{t-1} + \sum \varphi_j \Delta q_{t-j} + \epsilon_t \tag{5.9}$$

According to the ADF test results in Table 5.3, most developed countries can be characterized by nonstationary real exchange rates. Out of 20 cases under consideration, only in 2 cases can unit root null hypothesis be rejected at the 10% level or better. Interestingly, more rejections of unit root null cases occur for developing than for developed countries. The unit root behavior of the real exchange rates is rejected in 11 out of 32 countries. However, when variables in differences are considered, unit root null is uniformly rejected for both groups of countries.

The results of the half-life estimation are displayed in table 5.4. For the group of industrial countries alone, the half-life estimates are ranging from 2 to 5 years, which is similar to the findings of other studies in the literature. In contrast, the half-life estimates for developing countries appear much more dispersed than those for industrial countries. Most of the half-life estimates for developing countries lie between 1 and 3 years, except several countries like Singapore and Saudi Arabia with half-lives over 5 years. Accordingly, the persistence in the real exchange rate for emerging countries is less than for advanced countries. Such a difference in the persistence is consistent with different unit root rejection rates between the two country groups.

5.4 Risk And Bias Across Developed and Developing Countries

In analyzing whether the observed pattern of the persistence of real exchange rate swings is correlated with the forward bias, the significance of the correlation is measured and formally tested based on cross-country data. Since the usual distribution assumption of normality appears not tenable here, a nonparametric test is conducted. For a pair of variables, say $(x_{1,}x_2)$, the statistic is:

$$r_s = 1 - 6\sum_{j=1}^{N}[R(_{X1j}) - R(_{X2j})]^2/[N(N^2-1)] \tag{5.10}$$

where r_s is the Spearman rank correlation coefficient, N is the number of countries, $_{Xaj}(a=1,2)$ is the rank of the jth observation of series Xa, and $R(_{Xaj})$ is the smallest observed value of $_{Xaj}$. In general, $-1 \leqslant r_s \leqslant 1; r_s = 0$ for independent variables; $r_s N^{1/2}$ follows a standard normal distribution asymptotically.

Table 5.5 indicates that during the sample period industrial countries' forward rate predictions are generally more biased than those for developing countries. More importantly, the persistence of swings seems to be accounting for a significant part of this result. The rank correlation coefficient between the persistence of the gap, which is measured by the average deviations from the benchmark, and the forward bias is computed to be 0.75 with an approximate p-value of 0.00. The persistence of the exchange rate measured by the half-life of deviations from historical benchmark is also highly correlated with the forward bias. The coefficient is equal to 0.63 with an approximate p-value of 0.002. The correlation coefficient between the persistence of the exchange rate swing measured by the width of the threshold cointegration band and the forward bias is somewhat lower (0.59), but still has a positive sign and is significant at the 1% level.

To sum up, all correlation coefficients are statistically significant and positive. This result is robust across three different measures of the persistence of real exchange rate swings. The R^2 for the relationship between the forward bias and the persistence of the exchange rate swing is obtained by estimating the following regressions:

$$\widehat{\beta}_i = \alpha + \varphi Swing + \zeta_i \tag{5.11}$$

$$\left|1 - \widehat{\beta}_i\right| = \alpha + \varphi Swing + \zeta_i \tag{5.12}$$

where i is the country index. This is the cross-section regression, where $Swing$ is measured using three approaches: average deviations from the benchmark, the width of threshold cointegration bands, and the half-life of deviations from benchmark values. The third row of Table 5.5 shows that the degree of persistence of currency swings explains nearly half of the variation in the average absolute magnitude of the forward bias - the R^2 is equal to 0.43 for the average deviation of the exchange rate from its benchmark measure of exchange rate swings.

6 Conclusion

The results of this study undermine the commonly held view that the forward premium is a negatively biased predictor of the future change in the exchange rate in developed and developing countries. The structural break analysis of the Bilson-Fama regression for 52 currency markets provides evidence that the forward bias is not uniformly negative - there are stretches of time when it is negative, while during other stretches of time it is positive and either less than, equal to, or greater than one.

This finding implies that successive speculation in the foreign exchange market is not as simple as suggested by the voluminous literature on international finance. Indeed, the "predictable" profits cannot be made by simply betting against the forward rate. Although, this rule delivers profits in some subperiods for some currencies, it stops being profitable at moments of time that cannot be foreseen. No one can precisely specify ahead of time when the correlation might be negative and for how long, so no one can know in advance when it might be profitable to bet against or with the forward rate.

Moreover, allowing for the structural instability reveals a new empirical finding: the differences in the average size of the absolute forward bias between developed and developing countries are even more pronounced than previously documented by the literature, which estimates time-invariant pooled regression models. In particular, I find that the average forward bias is much greater for industrial than emerging market economies. These results suggest that what needs to be explained is not a negative forward bias but rather why this tendency for developed countries to be characterized by larger forward biases has been so pronounced.

In order to account for this finding, the paper adheres to the risk premium explanation. Specifically, this study shows that the IKE model of a time-varying risk premium developed by Frydman and Goldberg (2007) makes substantial progress in accounting for the variation of the forward biasedness across countries. The key feature of the IKE model is that the risk premium is measured by how far the exchange rate has deviated from its historical benchmark. According to this model, countries that are characterized by persistent movements in the exchange rate swings and the forward premium would also be characterized by larger forward rate biases.

I test the model's predictions empirically using three different specifications of a measure of the persistence of exchange rate swings to appropriately capture the size and persistence of the risk premium. In particular, I consider the following measures: a) average deviations from the historical benchmark b) the width of threshold cointegration bands, and c) the half-life of deviations from benchmark values. In the data, all three measures of the persistence of exchange rate swings are found to be positively correlated with the size of the forward bias. For instance, the correlation coefficient between the average deviations of the exchange rate from its benchmark value and the forward bias is equal to 0.75 and statistically significant at the 1 % level, providing robust corroboration to the IKE model of a time-varying premium.

I also find that developed countries are characterized by gaps from benchmark levels that are twice as large as for developing countries. These results provide strong empirical support for the important role of the foreign exchange risk premium in explaining the pattern of the forward-rate biasedness across countries.

The significance of the analysis is further supported by the intense debate over the appropriate degree of government interventions into the foreign exchange market and adequate choice of the exchange rate regime. Monetary authorities in many developing countries are concerned about pronounced exchange rate swings and misalignments, which is why they tend to adopt some type of managed floating exchange rate regime.

Departing from the standard paradigm has important implications for the way I think about the exchange rate policies. Frydman and Goldberg (2004, 2011) show that the connection between the risk premium and the gap implies a new channel for policy intervention that works through participants' forecasts of the potential losses. Frydman and Goldberg advance this new channel as one of several options that policy makers can pursue to limit excessive exchange rate swings away from benchmark levels.

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Appendix A

Table A.1: List of Countries

	Country	Currency	Starting	Ending	Number of Obs.
1	Argentina	ARG	Apr.1991	May-11	241
2	Australia	AUD	Dec.1984	May-11	317
3	Austria	AST	Dec.1987	May-11	280
4	Bahrain	BHD	May-00	May-11	133
5	Belgium	BEF	Dec. 1984	May-11	317
6	Brazil	BRL	Jan. 1995	May-11	196
7	Bulgaria	BGN	Jan. 1997	May-11	172
8	Canada	CAD	Dec. 1979	May-11	377
9	Chile	CLF	Jan. 1994	May-11	208
10	China	CNY	Jan. 1997	May-11	172
11	Colombia	COU	Mar. 1999	May-11	147
12	Czech Republic	CZK	Jan. 1997	May-11	171
13	Denmark	DKK	Dec. 1984	May-11	317
14	Estonia	EEK	Jan. 1997	May-11	172
15	Finland	FIM	Jan. 1997	May-11	172
16	France	FF	Dec. 1984	May-11	317
17	GermanyC	DEM	Dec. 1979	May-11	377
18	Greece	GRD	Jan. 1997	May-11	172
19	Hong Kong	HKD	Oct. 1993	May-11	331
20	Hungary	HUF	Nov. 1997	May-11	161
21	India	INR	Nov. 1997	May-11	161
22	Indonesia	IDR	Jan. 1997	May-11	172
23	Ireland	IEP	Aug. 1986	May-11	296
24	Israel	ILS	Jul. 1998	May-11	154
25	Italy	ITL	Dec. 1984	May-11	317
26	Japan	JPY	Aug. 1978	May-11	393
27	Korea	KRW	Apr. 1998	May-11	158
28	Latvia	LVL	Jan. 1998	May-11	162
29	Lithuania	LTL	Jan. 1998	May-11	161
30	Malaysia	MYR	Jan. 1999	May-11	148
31	Mexico	MXN	Jan. 1997	May-11	172
32	Netherlands	NLG	Dec. 1979	May-11	377
33	New Zealand	NZD	Dec. 1984	May-11	317
34	Norway	NOK	Dec. 1984	May-11	318
35	Peru	PEN	Apr. 1995	May-11	316
36	Philippines	PHP	Jan. 1997	May-11	172
37	Poland	PLN	Sep. 1996	May-11	176
38	Portugal	PTE	Dec. 1984	May-11	316
39	Romania	RON	Jan. 1997	May-11	172
40	Russia	RUB	Jan. 1997	May-11	172
41	Saudi Arabia	SAR	Jun. 1990	May-11	250
42	Singapore	SGD	Dec. 1984	May-11	317
43	Slovakia	SKK	May-93	May-11	217
44	Slovenia	SIT	Nov. 1992	May-11	223
45	South Africa	ZAR	Jun. 1990	May-11	241
46	Spain	ESP	Aug. 1986	May-11	297
47	Sweden	SEK	Dec. 1984	May-11	317
48	Switzerland	CHF	Dec. 1979	May-11	377
49	Taiwan	TWD	Jan. 1997	May-11	171
50	Thailand	THB	Mar. 1995	May-11	194
51	Turkey	TRY	Jan. 1997	May-11	172
52	UK	GBP	Dec. 1979	May-11	377

APPENDIX B

Table B.1: Classification of Countries

IMF Classification of Countries		World Bank Classification of Countries		
Developing Countries	Developed Countries	High Income Countries	Upper Middle Income Countries	Lower Middle Income Countries
Argentina	Australia	Australia	Argentina	China
Bahrain	Austria	Austria	Brazil	India
Brazil	Belgium	Bahrain	Bulgaria	Indonesia
Bulgaria	Canada	Belgium	Chile	Philippines
Chile	Denmark	Canada	Colombia	Thailand
China	Finland	Czech Republic	Latvia	
Colombia	France	Denmark	Lithuania	
Czech Rep	Germany	Estonia	Malaysia	
Estonia	Greece	Finland	Mexico	
Hong Kong	Ireland	France	Peru	
Hungary	Italy	Germany	Romania	
India	Japan	Greece	Russia	
Indonesia	Netherlands	Hong Kong	South Africa	
Israel	New Zealand	Hungary	Turkey	
Korea	Norway	Ireland		
Latvia	Portugal	Israel		
Lithuania	Spain	Italy		
Malaysia	Sweden	Japan		
Mexico	Switzerland	Korea		
Peru	U.K.	Netherlands		
Philippines		New Zealand		
Poland		Norway		
Romania		Poland		
Russia		Portugal		
Saudi Arabia		Saudi Arabia		
Singapore		Singapore		
Slovak Rep		Slovakia		
Slovenia		Slovenia		
S. Africa		Spain		
Taiwan		Sweden		
Thailand		Switzerland		
Turkey		Taiwan		
		UK		

World Bank Classification data are taken from April, 2010.

APPENDIX C

C.1 The IKE Risk-Premium Model

Like traditional portfolio-balance models of currency returns, the IKE model assumes that market participants choose at each point in time the proportion of domestic and foreign bonds they should hold so as to maximize next period's utility. This decision depends on participants' preferences and their forecasts of the return on foreign exchange.

C.1.1 A New Specification of the Risk Premium

The IKE model uses endogenous prospect theory to represent a participant's preferences and decision rule. One of the key assumptions of endogenous prospect theory is that an individual's degree of loss aversion increases with the size of their open positions in the market.[21] This assumption of "endogenous loss aversion" implies that market participants hold finite speculative positions in foreign exchange only if they expect a positive return – a risk premium – to compensate them for their extra sensitivity to the potential losses.[22]

Endogenous prospect theory leads to a new specification for an individual's risk premium, which depends on her forecast of the potential losses. For the group of bulls, this premium, which Frydman and Goldberg (2007) call an "uncertainty premium", can be written as follows:

$$\widehat{up}^{i}_{t|t+1} = (1 - \lambda_1)\, \widehat{l}^{i}_{t|t+1} > 0..i = \text{L,S} \tag{C.1}$$

where $\widehat{l}^{i}_{t|t+1}$ represents an aggregate of bulls' or bears' time-t point forecasts of the potential loss from holding a unit-sized open position for one period, and superscripts L and S denote long and short position, respectively.[23]

An individual's time-t forecast of the potential unit loss at $t+1$ is portrayed by the expected value of the "loss part" of a probability distribution for the one-period return on an open position.[24] For bulls, the "expected unit loss" is,

$$\widehat{l}^{\text{L}}_{t|t+1} = E^{\text{L}}_t[r_{t+1}|r_{t+1} < 0, Z^{\text{L}}_t] < 0 \tag{C.2}$$

while for a bear we have,

$$\widehat{l}^{\text{S}}_{t|t+1} = -E^{\text{S}}_t[r_{t+1}|r_{t+1} > 0, Z^{\text{S}}_t] < 0 \tag{C.3}$$

The point forecasts in (C.2) and (C.3) are conditional on individuals' forecasting strategies and information sets, Z^i_t. The one-period excess return on a long position in foreign exchange,

$$r_{t+1} = s_{t+1} - s_t + i^*_t - i_t \tag{C.4}$$

is expressed using a log approximation, where s_t denotes the log spot exchange rate and i_t and i^*_t are the nominal returns on domestic and foreign bonds, respectively. As such, the one-period return on a short position is given by $-r_{t+1}$. We note that losses for bulls (bears) involve negative (positive) realizations of r_{t+1}. Hence, the negative sign on $E^{\text{S}}_t[\cdot]$ in expression (C.3).

Risk in the model depends only on the loss part of the probability distribution that is used to represent the group of bulls' or bears' forecasting strategy, rather than on both the loss and gain parts as is the case with standard volatility measures. A higher $\widehat{l}^{i}_{t|t+1}$ implies that individuals attach a greater risk of capital loss

[21] Kahneman and Tversky's (1979) prospect theory assumes that individuals are "loss averse": the disutility that they would experience from a loss exceeds the utility from an equal magnitude gain.

[22] Behavioral-finance researchers refer to an individual's decision to hold a finite speculative position as "limits to arbitrage," which they consider to be one of the pillars of their approach (Barberis and Thaler, 2001). Endogenous prospect theory provides a way to model limits to speculation without abandoning any of the experimental findings of Kahneman and Tversky (1979) and others.

[23] The uncertainty premium in (C.1) is the minimum expected return that an individual requires in order to hold an open position in the market. The term, uncertainty premium, highlights Knight's (1921) distinction between uncertainty and risk, which recognizes that the risk in markets stems from the inherent imperfection of knowledge.

[24] As news arrives, an individual may revise her strategy for forecasting potential losses. The model represents the new forecasting strategy with a different probability distribution.

to speculating. Equation (C.1) shows that because individuals are endogenously loss averse ($\lambda_1 > 1$), a higher $\widehat{l}^i_{t|t+1}$, meaning a greater negative value, leads them to raise their uncertainty premium.

Endogenous prospect theory and portfolio balance lead to a new *momentary* equilibrium condition for the currency market. It is obtained by aggregating individuals' demands and supplies for foreign exchange using wealth shares and assuming that the exchange rate adjusts instantaneously to balance the total of buying and selling in the market at every point in time:

$$\widehat{r}_{t|t+1} = \widehat{up}_{t|t+1} + \lambda_2 IFP_t \tag{C.5}$$

where $\widehat{r}_{t|t+1} = \hat{s}_{t|t+1} - s_t + i^*_t - i_t$, $\hat{s}_{t|t+1}$ represents the aggregate of participants' conditional point forecasts of s_{t+1}, IFP_t is the international financial position of the domestic country relative to the foreign country, $\lambda_2 > 0$ is another preference parameter, and $\widehat{up}_{t|t+1}$ is the aggregate uncertainty premium,

$$\widehat{up}_{t|t+1} = \widehat{up}^{\text{L}}_{t|t+1} - \widehat{up}^{\text{S}}_{t|t+1} = \frac{1}{2}(1-\lambda_1)\left(\widehat{l}^{\text{L}}_{t|t+1} - \widehat{l}^{\text{S}}_{t|t+1}\right) \tag{C.6}$$

which depends on the uncertainty premium of bulls minus the uncertainty premium of bears.[25]

According to equation (C.5), momentary equilibrium is obtained when the expected return, $\widehat{r}_{t|t+1}$, offsets the uncertainty premium, $\widehat{up}_{t|t+1}$, sufficiently so that market participants in the aggregate willingly hold the available supplies of foreign and domestic bonds. The implied market premium – $\widehat{pr}_{t|t+1} = \widehat{up}_{t|t+1} + \lambda_2 IFP_t$ – depends on both the aggregate uncertainty premium and asset supplies.

C.1.2 Connecting Currency Risk to Perceptions of the Gap

In order to represent bulls' and bears' forecasts of the potential unit loss, Frydman and Goldberg (2007) appeal to an insight from Keynes (1936), that what matters for assessing risk in financial markets is the divergence between an asset's price and its perceived historical benchmark value. Although asset prices have a tendency to move persistently away from benchmark values for long stretches of time, they eventually undergo, at unpredictable moments, sustained movements back toward these values. Keynes recognized that market participants are aware of this regularity and use it in their attempt to assess the riskiness of their open positions. As he put it in discussing the bond market,

> [u]nless reasons are believed to exist why future experience will be very different from past experience, a ...rate of interest [much lower than the benchmark rate], leaves more to fear than to hope, and offers, at the same time, a running yield which is only sufficient to offset a very small measure of fear [of capital loss] (Keynes, 1936, p.202).

The model formalizes Keynes's insight with the following specification for bulls' and bears' forecasting strategies for the potential unit loss from speculating:

$$\widehat{l}^i_{t|t+1} = \mu_t + \delta^i_t \widehat{gap}_t + \varepsilon^i_t \quad i = \text{L,S} \tag{C.7}$$

where $\mu_t < 0$ is a mean value, $\delta^{\text{L}}_t < 0$ for bulls and $\delta^{\text{S}}_t > 0$ for bears, $\widehat{gap}_t = s_t - \hat{s}^{\text{BM}}_t$, $\hat{s}^{\text{BM}}_t$ is the perceived benchmark value, and ε_t is an error term that represents the influence of factors other than the gap on $\widehat{l}^i_{t|t+1}$, which are assumed not to have a systematic effect. The t subscripts on the parameters in (C.7) recognize that participants may revise how they interpret $\widehat{gap}_t$ in forecasting potential losses, at least intermittently, over time. We recall that $\widehat{l}^i_{t|t+1}$ is negative for both bulls and bears, so a negative δ^{L}_t and positive δ^{S}_t reflect Keynes's insight that a rising $\widehat{gap}_t$ leads bulls to increase and bears to decrease their forecasts of the *size* of the potential unit loss from speculating. We assume that the size of μ_t is sufficiently large to ensure that $\widehat{l}^i_{t|t+1} < 0$ regardless of

[25] In deriving equation (6), Frydman and Goldberg, like Delong et al. (1990), assume that the wealth share of bulls is constant and equal to that of bears, thereby implying that $\widehat{up}^{\text{L}}_{t|t+1}$ and $\widehat{up}^{\text{S}}_{t|t+1}$ enter the market premium with equal weights.

how $\widehat{gap}_t$ varies. We note that, in general, market participants have diverse notions of the benchmark value. However, whatever their notion, their estimates of the benchmark value vary much less than the exchange rate itself. Consequently, movements in a participants' estimate of $\widehat{gap}_t$ will be dominated by movements in s_t no matter how they estimate $\hat{s}_t^{\mathrm{BM}}$. And since the time series implications of the model depend on how $\widehat{gap}_t$ varies over time, we abstract from differences in estimates of $\hat{s}_t^{\mathrm{BM}}$.

With the specification in (C.7), we can write the aggregate uncertainty premium as:

$$\widehat{up}_{t|t+1} = \rho_t + \sigma_t \widehat{gap}_t + \varepsilon_t \tag{C.8}$$

where $\rho_t = \frac{1}{2}(1 - \lambda_1)\mu_t$, $\sigma_t = \frac{1}{2}(1 - \lambda_1)(\delta_t^{\mathrm{L}} - \delta_t^{\mathrm{S}}) > 0$, and ε_t depends on the errors in (C.7). In order to derive time series implications from the model, we need to represent how bulls and bears might revise their strategies for forecasting the potential unit loss, that is, we need restrictions on how the parameters μ_t and δ_t^i change over time.

Table 2.1: Conventional Fama Regression Analysis for Developed Countries

	Country	$\hat{\beta}$	Robust SE	$F: \alpha = 0, \beta = 1$	Prob>F	$t: \beta = 1$	# of obs.	Adj.R^2	Sample
1	Australia	-0.968	0.627	5.610***	0.004	-3.138***	317	0.0012	1984-2011
2	Austria	-0.814	1.008	1.412	0.245	-1.668*	280	-0.0012	1987-2011
3	Belgium	-1.138	0.882	3.415**	0.034	-2.423**	317	-0.0025	1984-2011
4	Canada	-0.417	0.556	6.042***	0.003	-2.547**	377	-0.0015	1979-2011
5	Denmark	0.079	0.734	2.18	0.114	-1.253	317	-0.0023	1984-2011
6	Finland	-3.117*	1.722	3.026*	0.051	-2.390**	172	-0.0007	1997-2011
7	France	-0.852	0.895	2.834*	0.06	-2.068**	317	-0.002	1984-2011
8	Germany	-0.695	0.662	3.309**	0.036	-2.557**	377	0.0011	1979-2011
9	Greece	2.103**	0.955	0.991	0.373	1.154	172	-0.0003	1997-2011
10	Ireland	0.38	0.977	0.676	0.509	-0.633	296	0.0302	1986-2011
11	Italy	0.171	0.92	1.531	0.217	-0.901	317	0.0309	1984-2011
12	Japan	-1.96***	0.674	9.72***	0	-4.39***	393	0.0349	1978-2011
13	Netherlands	-2.09**	0.82	7.28***	0	-3.77***	377	0.0172	1979-2011
14	New Zealand	-1.142**	0.53	11.24***	0	-4.036***	317	0.0339	1984-2011
15	Norway	-0.171	0.713	2.574*	0.077	-1.639	318	0.0299	1984-2011
16	Portugal	-0.221	0.428	4.696***	0.009	-2.846***	316	0.0316	1984-2011
17	Spain	0.149	0.668	1.413	0.244	-1.273	297	0.0311	1984-2011
18	Sweden	-0.024	1.122	0.856	0.425	-0.912	317	0.0332	1984-2011
19	Switzerland	-1.41**	0.668	6.609***	0.131	-3.60***	377	0.0124	1979-2011
20	U.K.	-1.549**	0.71	6.51***	0	-3.58**	377	0.01	1979-2011
21	Euro Area	-3.551*	2.135	2.363*	0.097	-2.131	149	-0.0013	1999-2011

Notes: Model I is estimated via OLS with Newey-West Standard Errors (forecast horizon is 1 month).
*, **, *** denotes significance at the 10%, 5% and 1% level. Constant terms in the regression are not reported. The joint significance for the null hypothesis that H_0: α_i=0,β_i=1 is tested and its Wald statistics and p-values are shown.
R^2 is adjusted for the degrees of freedom.

Table 2.2: Conventional Fama Regression Analysis for Developing Countries

	Country	$\hat{\beta}$	Robust SE	$F : \alpha = 0, \beta = 1$	Prob>F	$t : \beta = 1$	# of obs.	Adj. R^2	sample
1	Argentina	0.2395	0.307	3.116**	0.046	-2.471**	241	-0.0015	1991/4 - 2011
2	Bahrain	-0.042	0.066	5.18***	0	-15.61***	133	-0.0051	2000/5-2011
3	Brazil	0.325	0.281	8.420***	0	-2.391***	196	0.0014	1995/1-2011
4	Bulgaria	0.572	0.547	2.763*	0.065	-0.752	172	0.0023	1997/1-2011
5	Chile	-2.097*	1.091	6.866***	0.001	-2.837***	208	0.0124	1994/1-2011
6	China	-0.095	0.151	30.10***	0	-7.22***	172	-0.0022	1997/1-2011
7	Colombia	1.564***	0.3573	2.189	0.115	1.288	147	0.1107	1999/3- 2011
8	Czech Rep	1.434	0.923	1.0378	0.356	0.47	171	0.0068	1997/1-2011
9	Estonia	0.01	0.663	1.307	0.273	-1.491	172	-0.006	1997/1-2011
10	Hong Kong	0.126**	0.0502	163.0***	0	-17.37***	331	0.0159	1983/10-2011
11	Hungary	-0.064	1.023	3.597**	0.029	-1.039	161	-0.0062	1997/11-2011
12	India	-1.180*	0.604	7.158***	0.001	-3.609***	161	0.0166	1997/11-2011
13	Indonesia	0.255	0.225	6.879***	0.001	-3.295***	172	0.0042	1997/1-2011
14	Israel	-0.019	0.429	3.511**	0.032	-2.374**	154	-0.0065	1998/7-2011
15	Korea	0.558	0.587	1.494	0.227	-0.75	158	0.0007	1998/4-2011
16	Latvia	-0.562	0.676	2.950*	0.055	-2.307**	162	-0.0027	1997/12-2011
17	Lithuania	0.256	0.441	4.051**	0.019	-1.682*	161	-0.0058	1998/1-2011
18	Malaysia	-0.817	0.642	13.59***	0	-2.831***	148	0.0199	1999/1-2011
19	Mexico	0.043	0.325	6.981***	0.001	-2.939***	172	-0.0058	1997/1-2011
20	Peru	0.448**	0.178	9.613***	0.001	-3.084***	172	0.0171	1995/4-2011
21	Philippines	1.820*	0.999	1	0.369	0.821	172	0.0421	1997/1-2011
22	Poland	0.901*	0.498	2.134	0.121	-0.196	176	0.0066	1996/9-2011
23	Romania	0.383***	0.146	13.71***	0	-4.198***	172	0.0469	1995/8-2011
24	Russia	2.560**	1.038	3.158**	0.045	1.502	172	0.2197	1997/1-2011
25	Saudi Arabia	-0.097*	0.051	246.6***	0	-21.61***	250	0.0106	1990/6-2011
26	Singapore	0.682	0.566	0.200	0.818	-0.56	317	0.0051	1984/12-2011
27	Slovak Rep	0.696**	0.331	4.721**	0.009	-0.916	217	0.01153	1993/5-2011
28	Slovenia	0.261*	0.1453	14.46***	0	-5.083***	223	0.0047	1992/11-2011
29	South Africa	-1.028	1.136	1.898	0.152	-1.788*	241	-0.0007	1990/6-2011
30	Taiwan	0.761	0.491	0.510	0.601	-0.485	171	0.0077	1997/1-2011
31	Thailand	1.659***	0.517	1.992	0.139	1.274	194	0.1464	1995/3-2011
32	Turkey	0.008	0.038	340.8***	0	-26.03***	172	-0.0053	1997/1-2011

Notes: Model I is estimated via OLS with Newey-West Standard Errors (forecast horizon is 1 month).
*, **, *** denotes significance at the 10%, 5% and 1% level. Constant terms in the regression are not reported. The joint significance for the null hypothesis that H_0: α_i=0,β_i=1 is tested and its Wald statistics and p-values are shown.
R^2 is adjusted for the degrees of freedom.

Table 2.3: Developing Countries Structural Break Analysis

Developing Countries	Kejriwal and Perron test	CUSQ and one step Chow test
Argentina	1994:1, 1999:2, 2002:2, 2008:1	1991:9, 1992:10, 1994:2, 2001:8, 2002:6, 2004:9, 2008:7, 2009:3
Bahrain	2002:1, 2006:2, 2007:10	2001:9, 2002:9, 2003:6, 2005:1, 2006:6, 2007:6, 2008:9
Brazil	1998:9, 2001:2, 2003:3, 2008:10	1995:08, 1998:7, 1999:02, 2001:08, 2004:5, 2008:7, 2009:1
Bulgaria	2001:12, 2004:8, 2008:10	1997:08, 2000:10, 2003:1, 2008:7
Chile	1997:10, 2001:05, 2008:2	1995:5, 1997:10, 2001:10, 2005:11, 2007:8, 2008:3/10
China	2000:7, 2005:5, 2007:10, 2008:2	2000:9, 2002:3, 2005:6, 2006:5, 2007:11, 2008:6, 2010:8
Colombia	2002:11, 2006:8, 2008:5	2002:5, 2006:10, 2008:5
Czech Rep	1998:12, 2000:3, 2008:6	1998:1/10, 2000:9, 2008:5, 2009:2
Estonia	2000:9, 2008:8	2000:10, 2008:8
Hong Kong	1991:12, 1997:10, 2003:2, 2007:7	1991:12, 1994:1, 1997:11, 2003:9, 2007:11, 2008:8, 2010:5
Hungary	2000:6, 2007:7, 2009:8	2000:10, 2003:5, 2007:7, 2008:7, 2009:2
India	2001:11, 2003:12, 2007:7, 2009:8	2002:6, 2004:4, 2007:12, 2008:11, 2009:3
Indonesia	1997:11, 2001:5, 2008:9	1997:12, 1998:5, 2001:3, 2004:3, 2008:08, 2009:3
Israel	2000:6, 2002:5, 2007:1, 2008:6	2000:10, 2002:9, 2003:2, 2006:2, 2007:4, 2008:10
Korea	1999:12, 2004:6, 2007:1, 2008:11	1999:12, 2004:10, 2007:7, 2008:2/10, 2009:2
Latvia	2005:10, 2008:2	2005:11, 2008:12
Lithuania	2001:12, 2003:10, 2008:7	2002:1, 2005:3, 2008:12
Malaysia	2005:3, 2007:1, 2008:11	2005:7, 2007:4, 2008:11
Mexico	2006:5, 2008:10	1998:8, 2006:5, 2008:8, 2009:1
Peru	2005:10, 2008:2	2005:12, 2008:4, 2009:2
Philippines	1998:12, 2008:2	1998:9, 2005:9, 2007:6, 2008:2/10
Poland	2008:09:	2000:10, 2005:3, 2008:8, 2009:3
Romania	1998:11, 2004:11, 2008:9	1997:7, 1999:5, 2000:10, 2002:6, 2004:9, 2007:7, 2008:7, 2009:1
Russia	1998:4, 2000:1, 2008:10	1998:8, 1999:4, 2002:12, 2007:8, 2009:1
Saudi Arabia	1993:12, 1998:10, 2001:7, 2007:8	1993:12, 1994:6, 1996:5,1998:01, 2001:6, 2003:8, 2005:6, 2006:10, 2007:9
Singapore	1989:10, 1997:9, 2001:8, 2005:7	1990:1, 1995:4, 1997:12, 1998:8, 2001:8, 2002:5, 2005:11, 2008:11
Slovak Rep	2000:6, 2005:6, 2008:2	1994:3, 1999:7, 2000:10, 2002:2, 2005:11, 2008:9, 2009:2
Slovenia	2008:7	2000:10, 2004:12, 2008:1/12
South Africa	1995:7, 1998:7, 2001:8, 2007:7	1991:08, 1995:12, 1998:4/9, 2000:9, 2001:11, 2003:11, 2008:8
Taiwan	1998:10, 2001:4, 2005:2, 2008:10	1998:11, 2005:3, 2008:7, 2009:2
Thailand	1998:10, 2007:3	1997:6, 1998:10, 2007:5, 2008:11
Turkey	2001:1, 2008:7	1998:2, 2000:9, 2001:4/12, 2003:3, 2008:8/12

Table 2.4: Developed Countries Structural Break Analysis

Developing Countries	Kejriwal and Perron test	CUSQ and one step Chow test
Australia	1988:12, 2004:1, 2006:4, 2008:10	1987:7, 1988:11, 1993:9, 1998:8, 2004:1, 2007:8, 2008:7, 2011:5
Austria	1991:2, 2001:1, 2008:10	1991:4, 1992:9, 1995:3, 2000:10, 2005:11, 2008:7, 2009:2
Belgium	1991:1, 2001:1, 2004:8, 2008:7	1990:12, 1992:8, 1995:3, 2000:4/11, 2005:11, 2008:7, 2009:2
Canada	1985:11, 1991:9, 2003:4, 2008:9	1982:6, 1991:10, 1992:8,00:10, 2002:11, 2004:11, 2008:5, 2009:2
Denmark	1990:12, 1992:7, 2005m7, 2008:10	1987:12, 1990:11, 1992:8, 1993:8, 1995:3, 2005:11, 2008:7, 2009:1
Finland	2001:1, 2005:7, 2008:7	1998:10, 2005:11, 2008:7, 2009:2
France	2001:1, 2004:8, 2008:10	1990:11, 1992:7, 1994:1, 2000:10, 2002:2, 2008:7, 2009:2
Germany	1985:10, 1990:1, 2001:1, 2004:8, 2008:10	1985:2, 1990:1, 1991;6, 1992;7, 1995:4, 1999:10,
		2000:10, 02:2, 05:11, 08:7, 09:2
Greece	2000:9, 2008:8	2000:10, 2002:2, 2005:11, 2008:8, 2009:2, 1989:7, 1991:6, 1992:8,
Ireland	1991:1, 1992:12, 2005:7, 2008:8	1998:3, 2000:10,
		2002:2, 2005:11, 2008:7, 2009:2
Italy	1990:8, 1993:8, 2001:10, 2005:7, 2008:6	1989:6, 1990:11, 1992:7, 1995:5, 2000:10, 2002:2, 2005:11, 08:7,
		2009:2
Japan	1985:1, 1990:10, 1995:1, 1999:8, 2008:7	1982:04, 1985:9, 1990:10, 1991:2, 1995:1,
		1998:07, 2000:5, 2007:6, 2008:8
Netherlands	1985:10, 1990:1, 1993:3, 2001:3, 2008:10	1985:2, 1991:1, 1992:8, 1993:12, 1998:8, 2002:2,
		2005:11, 2008:12, 2009:9
New Zealand	1986:11, 1988:8, 1992:6, 2000:9, 2004:1	1986:9, 1988:9, 1990:9, 1997:5, 1998:9, 2005:3, 08:7, 09:10
Norway	1986:11, 1988:5, 1990:12, 1992:7, 2000:9	1986:5, 1989:6, 1991:1, 1992:10, 1995:3, 1997:8, 2000:10,
		2008:7, 2009:2
Portugal	1985:5, 1981:1, 1993:3, 2000:1, 2008:5	1986:5, 1987:11, 1991:1, 1992:8, 1993:12,
		2000:10, 2002:2, 2005:11, 08:7, 09:2
Spain	1989:7, 1991:2, 1992:9, 2001:2, 2005:1	1990:10, 1991:6, 1992:8, 1993:08, 1997:7,
		2000:10, 2002:2, 2005:11, 08:7, 09:2
Sweden	1992:8, 2005:7, 2008:10	1989:11, 1990:10, 1992:8, 1993:12, 1997:3, 2000:6,
		2005:11, 08:7, 09:4
Switzerland	1982:9, 1986:7, 1990:4, 2000:10, 2009:1	1982:10, 1985:2, 1990:11, 1992:9, 1993:12, 1997:8,
		2005:11, 2008:3, 09:2
U.K.	1980:9, 1985:1, 1992:7, 2005:1, 2008:9	1985:2, 1988:11, 1991:2, 1992:7,
		1995:4, 1997:8, 2002:3, 2004:12, 08:7, 09:3

Figure 2.1: Developed Countries Structural Break Test Results

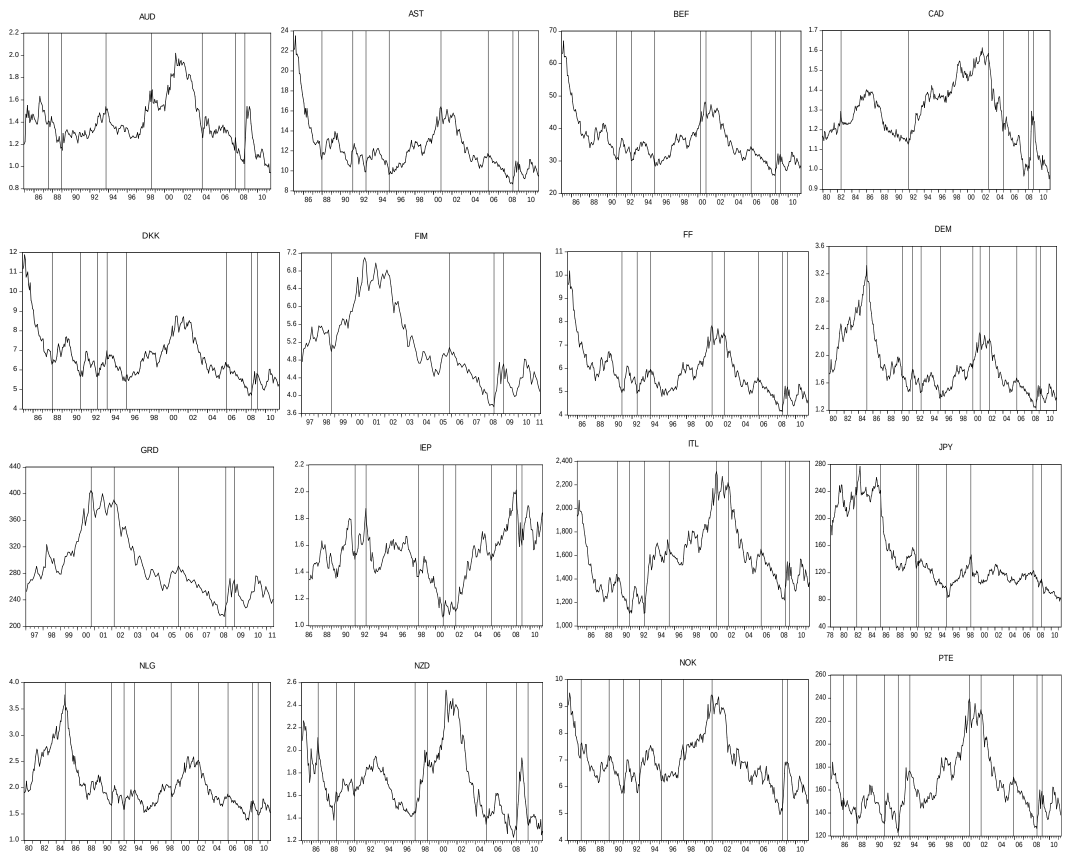


Figure 2.2: Developing Countries Structural Break Test Results

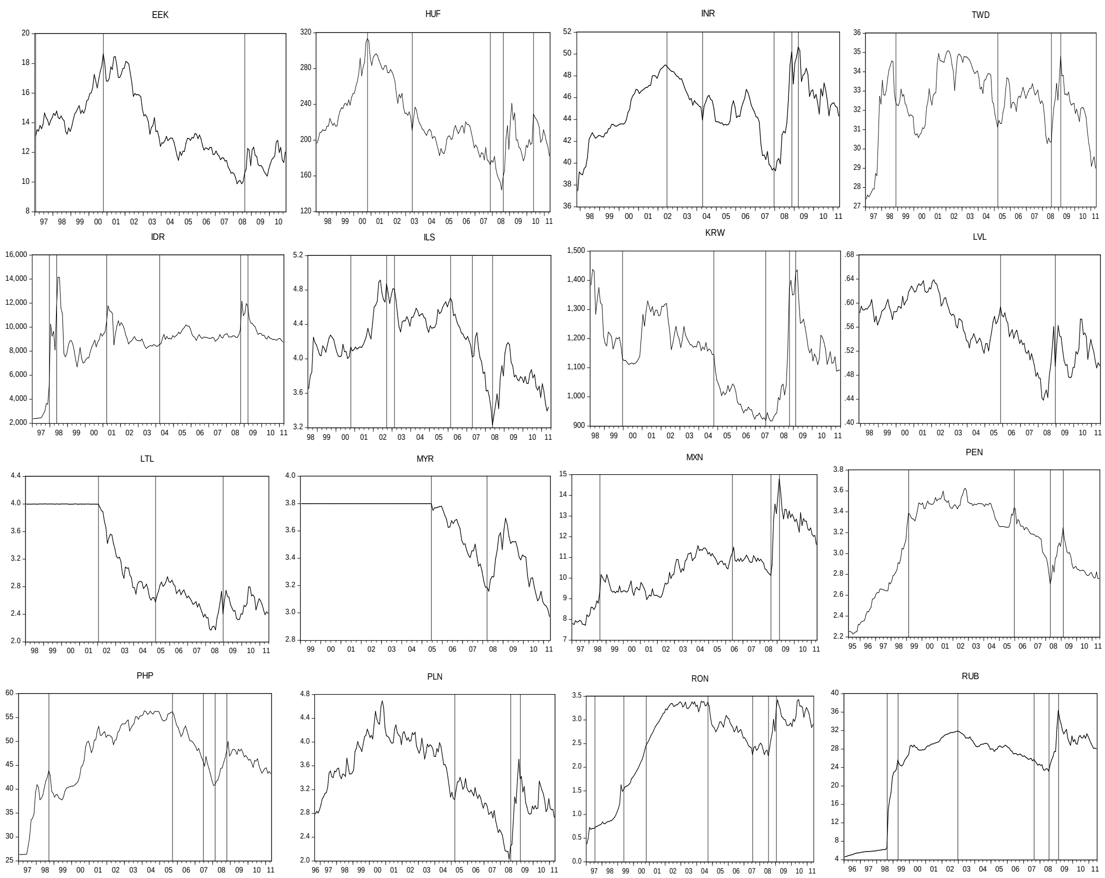


Table 2.5: Subsample BF Regression with Breaks for Developing Countries

Country	1	2	3	4	5	6
Argentina	92:11-94:2	94:3-01:8	02:07 - 04:09	04:10-08:7	09:3-11:5	
$\hat{\beta}_i$	0.15**	-0.02*	-0.21	-0.85	0.39	
$t(\hat{\beta}_i = 1)$	-15.09***	-10.6***	-3.51***	-2.63**	-0.47	
Bahrain	03:6 -05:2	05:3-06:6	08:10-11:5			
$\hat{\beta}_i$	-0.58	1.00**	0.05			
$t(\hat{\beta}_i = 1)$	-7.55***	0.01	-19.3***			
Brazil	95:8-98:7	99:3-01:8	01:9-04:5	04:6-08:7	09:2-11:5	
$\hat{\beta}_i$	0.06	-2.32**	-3.77*	0.38	1.37	
$t(\hat{\beta}_i = 1)$	-16.8***	-3.09***	-2.25**	-0.87	0.4	
Bulgaria	97:9-00:10	00:11-03:1	03:2-08:7	08:8-11:5		
$\hat{\beta}_i$	0.3	1.6	-0.72	1.32		
$t(\hat{\beta}_i = 1)$	-0.16	0.2	-0.73	0.09		
Chile	95:6-97:10	97:11-01:10	01:11-05:6	05:7-07:8	08:11-11:05	
$\hat{\beta}_i$	3.21	2.04	-3.09	-11.33	17.74	
$t(\hat{\beta}_i = 1)$	0.4	0.23	-0.59	-1.56	2.23**	
China	97:1-00:9	00:10-02:3	02:4-05:6	06:6-07:11	08:6-10:8	
$\hat{\beta}_i$	-0.02	0.0006	2.38	-3.35***	-0.92*	
$t(\hat{\beta}_i = 1)$	-85.6***	-15.6***	0.79	-4.97***	-3.60***	
Colombia	02:06-06:10	06:11-08:5	08:6-11:5			
$\hat{\beta}_i$	1.27**	-0.54	2.42***			
$t(\hat{\beta}_i = 1)$	0.48	-1.41	1.72*			
Czech Rep.	98:11-00:09	00:10-08:6	08:7-11:5			
$\hat{\beta}_i$	1.27	-1.06	1.69			
$t(\hat{\beta}_i = 1)$	0.07	-1.53	0.02			
Estonia	97:1-00:10	00:11-08:8	08:9-11:5			
$\hat{\beta}_i$	-0.22	-0.016	-1.64			
$t(\hat{\beta}_i = 1)$	-1.54	-0.56	-0.82			
Hong Kong	88:1-91:12	92:1-94:1	94:2-97:11	97:12-03:9	03:10-07:11	08:9-10:5
$\hat{\beta}_i$	0.04	0.31*	0.032**	0.13**	-0.83***	5.15***
$t(\hat{\beta}_i = 1)$	-19.02***	-4.16***	-4.82***	-15.3***	-6.05***	3.08***
Hungary	97:11-00:10	00:11-03:5	03:6-07:7	09:2-11:5		
$\hat{\beta}_i$	-0.99	-0.28	-1.22	-3.85		
$t(\hat{\beta}_i = 1)$	-1.67	-0.4	-2.23**	-0.82		
India	97:11-02:6	02:7-04:4	04:5-07:12	09:4-11:5		
$\hat{\beta}_i$	-1.89***	-1.85	-4.07***	0.92		
$t(\hat{\beta}_i = 1)$	-4.17***	-2.06*	-6.63***	-0.04		
Indonesia	98:6-01:3	01:4-04:4	04:5-08:8	09:4-11:5		
$\hat{\beta}_i$	-2.12***	0.34*	0.98	-0.25		
$t(\hat{\beta}_i = 1)$	-4.218***	-3.60***	0.34	-0.37		
Israel	98:6-00:10	00:11-02:9	03:3-06:2	08:11-11:5		
$\hat{\beta}_i$	-0.99**	2.00***	-1.09**	-0.66		
$t(\hat{\beta}_i = 1)$	-4.88***	1.53	-5.15***	-1.78*		
South Korea	98:4-99:12	00:1-04:10	04:11-07:7	09:3-11:5		
$\hat{\beta}_i$	2.38*	-1.1	-1.50*	3.02**		
$t(\hat{\beta}_i = 1)$	1.19	1.77*	-3.21***	1.46		
Latvia	97:12-05:11	05:12-08:12	09:1-11:5			
$\hat{\beta}_i$	-0.94	0.59	-0.89			
$t(\hat{\beta}_i = 1)$	-2.59	-0.19	-2.05**			

Notes: Model I is estimated via OLS with Newey-West Standard Errors (standard errors are not reported).
*, **, *** denotes significance at the 10%, 5% and 1% level. Constant terms in the regression are not reported.
The t test for the null hypothesis that H_0: ,β_i=1 is tested and its statistics are shown.

Table 2.5 (*continued*): Developing Countries Estimation Results

Country	1	2	3	4	5	6
Lithuania	98:1-02:1	02:2-05:3	05:4-08:12	09:1-11:5		
$\hat{\beta}_i$	0.013	-2.52	2.51	-3.21		
$t(\hat{\beta}_i = 1)$	-49.1***	-0.57	0.35	-0.19		
Malaysia	99:01-05:7	05:8-07:4	08:12-11:5			
$\hat{\beta}_i$	-0.025	4.75**	0.67			
$t(\hat{\beta}_i = 1)$	-38.7***	1.89**	-0.38			
Mexico	98:9-06:5	06:6-08:8	09:2-11:5			
$\hat{\beta}_i$	-0.82**	1.35	2.25			
$t(\hat{\beta}_i = 1)$	-5.37***	0.08	0.28			
Peru	95:4-05:12	06:1-08:4	08:12-11:5			
$\hat{\beta}_i$	0.14	-3.55	0.9			
$t(\hat{\beta}_i = 1)$	-4.44***	-1.36	-0.04			
Philippines	97:1-98:9	98:10-05:9	05:10-07:6	08:11-11:5		
$\hat{\beta}_i$	2.29*	-1.83	0.162	-1.21		
$t(\hat{\beta}_i = 1)$	1.1	-2.56**	-0.34	0.9		
Poland	96:9-05:3	05:4-08:8	09:4-11:5			
$\hat{\beta}_i$	1.107	3.06	-1.6			
$t(\hat{\beta}_i = 1)$	0.14	0.53	-0.09			
Romania	97:7-99:5	99:6-00:10	00:11-02:6	02:7-04:9	04:10-07:7	09:2-11:5
$\hat{\beta}_i$	0.02	-0.57***	1.05***	1.4	-2.60**	-3.69*
$t(\hat{\beta}_i = 1)$	-2.31**	-12.02***	0.16	0.2	-3.15***	-2.18**
Russia	99:5-02:12	03:1-07:8	07:9-08:12	09:2-11:5		
$\hat{\beta}_i$	1.44*	-0.4	9.72***	-3.19***		
$t(\hat{\beta}_i = 1)$	0.55	-2.66**	3.40***	-4.10***		
Saudi Arabia	90:6-93:12	94:7-96:5	98:01-01:6	03:8-05:6	08:12-11:5	
$\hat{\beta}_i$	-0.007	-0.14***	-0.04	0.019	-0.44**	
$t(\hat{\beta}_i = 1)$	-12.8***	-29.4***	-30.11***	-20.74***	-7.12***	
Singapore	84:12-90:1	90:2-95:4	95:5-97:12	98:9-01:8	02:6-05:11	05:12-08:11
$\hat{\beta}_i$	-3.72**	0.34	4.11***	-4.79**	1.37	-7.19**
$t(\hat{\beta}_i = 1)$	-2.65**	-0.95	6.13***	-2.59***	0.3	-2.69**
Slovakia	94:4-99:7	00:10-02:2	02:3-05:11	05:12-08:9	09:1-11:5	
$\hat{\beta}_i$	0.64*	2.55	-3.25**	2.13	5.59	
$t(\hat{\beta}_i = 1)$	-1	0.52	-3.11***	0.15	0.22	
Slovenia	92:11-00:10	00:11-04:12	05:1-08:1	09:1-11:5		
$\hat{\beta}_i$	0.01	0.88	5.01*	0.91		
$t(\hat{\beta}_i = 1)$	6.08***	-0.02	1.61	-0.01		
South Africa	91:9-95:12	96:1-98:4	98:10-00:9	01:12-03:11	03:12-08:8	09:3-11:5
$\hat{\beta}_i$	0.14	-6.97**	-3.62*	0.64	-1.29	-0.1
$t(\hat{\beta}_i = 1)$	-0.78	-2.56**	-1.78	-0.04	-0.9	-5.17***
Taiwan	98:12-05:3	05:4-08:7	09:3-11:5			
$\hat{\beta}_i$	0.91	1.91	-2.96*			
$t(\hat{\beta}_i = 1)$	-0.12	0.74	-2.46**			
Thailand	98:11-07:5	07:6-08:11	08:12-11:5			
$\hat{\beta}_i$	-2.39***	1.48	0.58			
$t(\hat{\beta}_i = 1)$	-4.11***	0.2	-0.21			
Turkey	98:3-00:09	02:1-03:3	03:4-08:8	09:1-11:5		
$\hat{\beta}_i$	0.41**	0.12	-1.46**	-2.46		
$t(\hat{\beta}_i = 1)$	-3.78***	-2.50*	-3.44***	-1.08		

Notes: Model I is estimated via OLS with Newey-West Standard Errors (standard errors are not reported).
*, **, *** denotes significance at the 10%, 5% and 1% level. Constant terms in the regression are not reported.
The t test for the null hypothesis that H_0: ,βi=1 is tested and its statistics are shown.

Table 2.6: Subsample BF Regression with Breaks for Developed Countries

Country	1	2	3	4	5	6	7
Australia	84:12-87:7	88:12-93:9	93:10-98:8	98:9-04:1	04:2-07:8	08:8-11:5	
$\hat{\beta}_i$	-11.96***	-1.71	-10.82***	-6.65***	4.24	13.27	
$t(\hat{\beta}_i = 1)$	-4.67***	-2.30**	-3.39***	-3.89***	0.73	1.02	
Austria	87:12-91:4	92:9-95:3	95:4-05:11	05:12-08:7	09:3-11:5		
$\hat{\beta}_i$	15.27***	5.95	-5.32***	2.85	-15.63		
$t(\hat{\beta}_i = 1)$	2.73***	0.79	-4.43***	0.39	-0.43		
Belgium	84:12-90:12	92:9-95:3	95:4-00:4	00:12-05:11	05:12-08:7	09:3-11:5	
$\hat{\beta}_i$	-5.53**	4.37**	-8.71	-7.11**	2.85	4.06	
$t(\hat{\beta}_i = 1)$	-2.83***	1.89*	-1.24	-2.73***	0.39	0.11	
Canada	79:12-82:6	82:7-91:10	92:9-00:10	00:11-02:10	02:11-04:11	04:12-08:5	09:3-11:5
$\hat{\beta}_i$	0.45	-1.30**	-0.43	9.25*	1.84	6.54	9.43
$t(\hat{\beta}_i = 1)$	-0.66	-3.90***	-1.32	1.73*	0.07	1.09	0.87
Denmark	84:12-87:12	88:1-90:11	90:12-92:9	93:9-95:3	95:4-05:11	05:12-08:7	09:2-11:5
$\hat{\beta}_i$	6.93	-5.5	-6.71	4.81**	-5.36***	3.26	5.11
$t(\hat{\beta}_i = 1)$	1.35	-3.08***	1.34	1.91*	-3.90***	0.45	0.29
Finland	98:11-05:11	05:12-08:7	09:2-11:5				
$\hat{\beta}_i$	-5.56***	2.87	-10.06				
$t(\hat{\beta}_i = 1)$	-4.27***	0.4	-0.35				
France	84:12-90:11	90:12-92:7	94:2-00:10	00:11-02:2	02:3-05:11	05:12-08:7	09:2-11:5
$\hat{\beta}_i$	-5.65**	-8.32	-4.85***	10.85	-9.45***	2.85	-10.2
$t(\hat{\beta}_i = 1)$	-2.55**	-1.81*	-3.66***	0.25	-3.44***	0.39	-0.35
Germany	79:12-85:2	85:3-90:1	92:8-95:4	95:5-99:10	00:11-02:2	02:3-05:11	09:3-11:5
$\hat{\beta}_i$	0.26	-10.02**	4.05**	8.85***	10.54	-9.49***	6.1
$t(\hat{\beta}_i = 1)$	-0.38	-2.85***	1.78*	2.94***	1.24	-3.47***	0.2
Ireland	86:8-89:7	92:8-98:3	98:4-00:10	00:11-02:2	02:3-05:11	05:12-08:7	09:3-11:5
$\hat{\beta}_i$	-1.33	2.25***	-7.85**	10.51	-9.48***	2.83	-16.89
$t(\hat{\beta}_i = 1)$	-1.71	1.96	-2.70**	1.23	-3.45***	0.39	-0.46
Italy	84:12-89:6	92:8-95:5	95:6-00:11	00:12-02:2	02:3-05:11	05:12-08:7	09:2-11:5
$\hat{\beta}_i$	-4.67***	4.97***	-1.90**	2.2	-9.46***	2.85	-10.03
$t(\hat{\beta}_i = 1)$	-3.42***	2.28**	-2.32	0.23	-3.4***	0.39	-0.34
Japan	82:4-85:9	85:10-90:10	91:2-95:1	95:2-98:7	98:8-00:5	00:6-07:6	08:9-11:5
$\hat{\beta}_i$	-7.47***	-9.09***	0.76	-34.9*	10.7	-3.45**	22.45***
$t(\hat{\beta}_i = 1)$	-4.72***	-3.72***	-0.12	-2.09*	0.57	-2.90***	3.93***
Netherlands	79:12-85:2	85:3-91:1	94:1-98:8	98:9-02:2	02:3-05:11	05:12-08:12	09:2-11:5
$\hat{\beta}_i$	-1.02	-4.22	-8.83***	-1.79	-7.63***	4.62	-13.33
$t(\hat{\beta}_i = 1)$	-1.2	-1.70*	-4.36***	-1.3	-3.37***	0.86	-0.69
New Zealand	84:12-86:9	86:10-88:9	88:10-90:8	90:10-97:5	98:10-05:3	05:4-08:7	09:10-11:5
$\hat{\beta}_i$	-4.88***	-3.56*	-7.68*	1.97	-4.64***	8.48**	-38.2**
$t(\hat{\beta}_i = 1)$	-4.54***	-2.56	-2.04*	0.57	-3.34***	2.07**	-2.73**
Norway	84:12-86:5	86:6-89:6	89:7-91:1	92:11-95:3	95:4-97:8	97:9-00:10	09:2-11:5
$\hat{\beta}_i$	23.61***	-3.14**	-7.9	5.14***	-13.24**	-0.089	22.93
$t(\hat{\beta}_i = 1)$	3.45***	-2.91***	-1.49	3.71***	-2.79**	-0.64	1.52
Portugal	84:12-87:11	87:12-91:1	94:1-00:10	00:11-02:2	02:3-05:11	05:12-08:7	09:3-11:5
$\hat{\beta}_i$	-0.21	3.65*	-2.13***	10.44	-9.42***	2.88	-15.9
$t(\hat{\beta}_i = 1)$	-1.41	1.44	-4.06***	1.22	-3.43***	0.4	-0.44
Spain	86:6-90:10	93:9-97:7	97:8-00:10	00:11-02:2	02:3-05:11	05:12-08:12	09:1-11:5
$\hat{\beta}_i$	-4.02**	-2.22	-12.54**	10.56	-9.46***	5.42	4.9
$t(\hat{\beta}_i = 1)$	-2.79***	-1.14	-2.47**	1.24	-3.44***	0.98	0.15

Notes: Model I is estimated via OLS with Newey-West Standard Errors (standard errors are not reported).
*, **, *** denotes significance at the 10%, 5% and 1% level. Constant terms in the regression are not reported.
The t test for the null hypothesis that H_0: ,βi=1 is tested and its statistics are shown.

Table 2.6 (*continued*): Developed Countries Estimation Results

Country	1	2	3	4	5	6	7
Sweden	84:12-89:11	90:10-92:8	94:1-97:2	97:4:-00:6	00:7-05:11	05:12-08:12	09:1-11:5
$\hat{\beta}_i$	-4.27***	4.53	-9.00***	2.97	-6.74***	7.5	15.47
$t(\hat{\beta}_i = 1)$	-4.33***	0.67	-3.99***	0.29	-3.57***	1.34	1.54
Switzerland	82:10-90:11	90:12-92:9	92:10-93:12	94:1-97:8	97:9-05:11	05:12-09:2	09:2-11:5
$\hat{\beta}_i$	-4.23***	-9.28	30.43**	-7.84***	-4.08**	3.16	13.26
$t(\hat{\beta}_i = 1)$	-3.32***	-1.27	2.58	-3.24***	-2.50**	0.55	0.71
UK	85:2-88:11	88:12-91:02	92:8-95:4	95:5-97:8	97:9-02:3	02:4-08:7	09:4-11:5
$\hat{\beta}_i$	-8.60*	-11.82***	8.63***	36.23***	-2.86	2.16	9.8
$t(\hat{\beta}_i = 1)$	-2.18**	-3.37***	6.06***	4.49***	-1.48	0.51	0.56

Notes: Model I is estimated via OLS with Newey-West Standard Errors (standard errors are not reported).
*, **, *** denotes significance at the 10%, 5% and 1% level. Constant terms in the regression are not reported.
The t test for the null hypothesis that H_0: ,βi=1 is tested and its statistics are shown.

Table 3.1: Pooled Country Regressions

Pooled Data	Method	Dates	N	β	$t:\ \beta = 0$	$t:\ \beta = 1$	F-Prob
DC	Pooled Regression	1997M01- 2011M05	2068	-0.84**	-2.28**	-5.01***	0.00
				(-0.02)			
LCD		1997M01- 2011M05	3621	0.050***	3.38***	-54.23***	0.00
				(0.000)			
DC	Fixed Effects	1997M01- 2011M05	2068	-1.82***	3.66***	-5.66***	0.00
				(0.000)			
LCD		1997M01- 2011M05	3621	0.056***	3.21***	-53.4***	0.00
				(-0.001)			
HI		1997M01- 2011M05	3363	-0.009***	-0.56	-63.8***	0.00
				(-0.57)			
UMI	Pooled Regression	1997M01- 2011M05	1873	0.60***	7.89***	-5.16***	0.00
				(0.000)			
LMI		1997M01- 2011M05	684	0.355***	3.42***	-6.19***	0.00
				(0.000)			
HI	Fixed Effects	1997M01- 2011M05	3363	-0.002	-0.12	-62.8***	0.00
				(-0.97)			
UMI		1997M01- 2011M05	1873	0.70***	7.45***	-3.15***	0.00
				(-0.001)			
LMI		1997M01- 2011M05	684	0.343***	3.27***	-6.27***	0.00
				(0.000)			

Notes: Panel fixed effects and pooled regression point estimates with robust standard errors.
*, **, *** denotes significance at the 10%, 5% and 1% level. Constant terms in the regression are not reported.
p-values are shown in parentheses. The joint significance for the null hypothesis that H_0: αi=0,βi=1 is tested via Wald test with p-values reported in the last column. Pooled analysis of emerging economies does not include countries that have their start date after 1/97. Pooled analysis of industrial countries does not include the Euro countries.

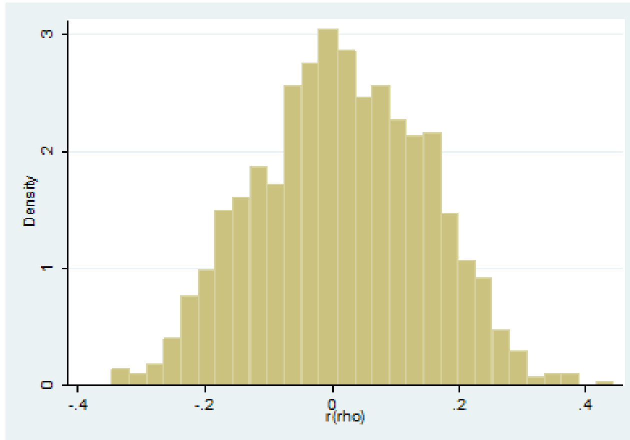
Table 3.2: Average Size of the Forward Bias across Subsamples of Stability

Developing Countries	Average Forward Bias	Developed Countries	Average Forward Bias
Malaysia	0.6	Greece	5.52
Taiwan	0.79	Sweden	5.56
Bahrain	0.84	Denmark	5.78
Bulgaria	0.85	Canada	5.86
Czech Rep.	1.01	Portugal	5.9
Argentina	1.12	Italy	6.02
Israel	1.13	Netherlands	6.4
Colombia	1.14	Belgium	6.64
Mexico	1.15	Finland	6.76
Saudi Arabia	1.16	Chile	7.31
Indonesia	1.33	Germany	7.55
Latvia	1.41	Spain	7.65
Thailand	1.42	France	7.82
Hong Kong	1.59	Australia	8.52
Estonia	1.63	Ireland	8.94
Poland	1.66	Austria	9.37
Slovenia	1.67	Switzerland	9.58
Philippines	1.77	Norway	9.71
Peru	1.83	New Zealand	10.34
Turkey	1.85	UK	11.24
Romania	1.87	Japan	11.52
China	1.93		
Brazil	2		
Korea	2.02		
Lithuania	2.57		
Hungary	2.59		
India	2.72		
South Africa	3.28		
Slovakia	3.52		
Singapore	3.54		
Russia	3.72		

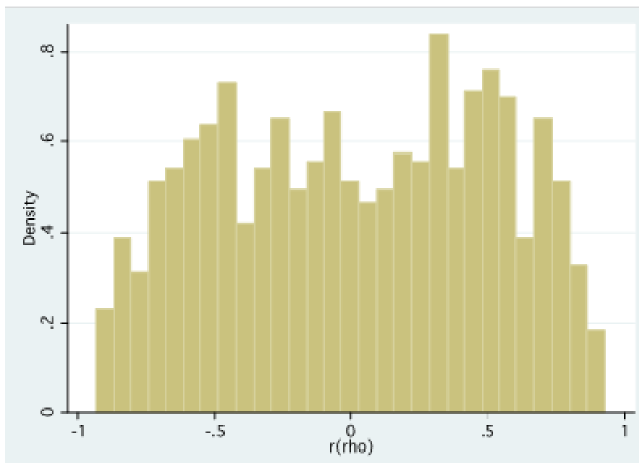
Notes: The size of the forward bias is given in absolute values. It is calculated by taking averages over the subsamples of relative parameter stability

Figure 4.1: Frequency Distribution of the Correlation Coefficient for Different Degrees of Persistence

(a) Frequency distribution for the correlation coefficient between two stationary processes (T=100)



(b) Frequency distribution for the correlation coefficient between two I(1) processes (T=100)



(c) Frequency distribution for correlation coefficient between two I(2) processes (T=100)

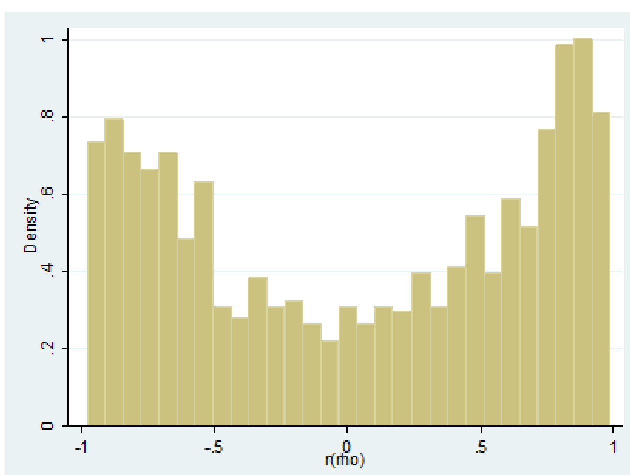


Table 5.1: Average Deviations from Benchmark for Emerging and Developed Economies

Developing Countries	Ave. Dev.	Trend	t-val	P-val	Developed Countries	Ave. Dev.	Trend	t-val	P-val
Argentina1	5.45	0.0002	1.36	0.17	Australia	12.73	-0.0002	-1.62	0.14
Argentina2		-0.001	-9.64	0	Austria	13.37	-0.0017	-0.001	0.46
Bahrain	4.22	0.0003	7.42	0.29	Belgium	14.3	0.0004	0.148	0
Brazil	10.06	0.0001	0.13	0.89	Canada	13.31	0.0001	1.3	0.19
Bulgaria	9.73	-0.009	-23.3	0	Denmark	11.25	-0.0007	-1.37	0.17
Chile	13.07	0.0919	0.74	0.46	Finland	13.35	-0.018	-10.6	0
China	4.34	0.002	4.03	0	France	7.41	0.0003	1.1	0.27
Colombia	9.2	-7.168	-12.6	0	Germany	13.41	0.0003	1.73	0.08
Czech Rep	8.69	-0.185	-28.9	0	Greece	11.67	-1.89	-13.8	0
Estonia	9.77	-0.049	-20.4	0	Ireland	9.37	0.0003	2.19	0.03
Hong Kong	13.24	-0.005	-8.18	0	Italy	12.73	-0.227	-1.41	0.16
Hungary	11.13	-1.1	-23.7	0	Japan	14.74	-0.052	-6.13	0
India	6.38	-0.216	-20.1	0	Netherlands	13.07	0	-0.45	0.65
Indonesia	7.29	-87.92	-9.2	0	New Zealand	14.62	-0.0001	-0.72	0.47
Israel	7.26	-0.0017	-2.92	0.004	Norway	12.62	0.0004	0.91	0.35
Korea	7.98	-1.55	-7.9	0	Portugal	14.14	-0.409	-12.7	0
Latvia	6.81	-0.0019	-25.9	0	Spain	11.42	-0.0152	-1.02	0.31
Lithuania	5.86	-0.011	-34.6	0	Sweden	10.24	0.005	8.92	0
Malaysia	2.48	-0.0017	-18	0	Switzerland	12.78	-0.0008	-1.11	0.17
Mexico	7.01	-0.041	-18	0	U.K.	11.98	0	-0.12	0.9
Peru	8.84	0.0003	0.92	0.35	Average	12.89			
Philippines	5.18	-0.027	-2.38	0.03	X^2-stat.	20.8***			
Poland	7.93	-0.017	-22.1	0					
Romania	10.84	-0.018	-18.4	0					
Russia	19.57	-0.11	-9.68	0					
Saudi Arab.	5.01	0.0063	17.1	0					
Singapore	8.93	0	0.37	0.71					
Slovak Rep	12.08	-0.179	-26.6	0					
Slovenia	8.42	-0.229	-8.12	0					
S. Africa	15.37	0.037	31.9	0					
Taiwan	4.8	0.059	9.88	0.07					
Thailand	7.61	0.003	0.41	0.67					
Turkey	10.61	-0.007	-19.1	0					
Average	8.59								
X^2-stat.	20.8***								

Notes: Average deviations from benchmark are calculated as average deviations from time trends.
The t-test statistics for significance of time trends are reported together with p-values.

Figure 5.1: Developing Countries Real Exchange Rates with Fitted Time Trends

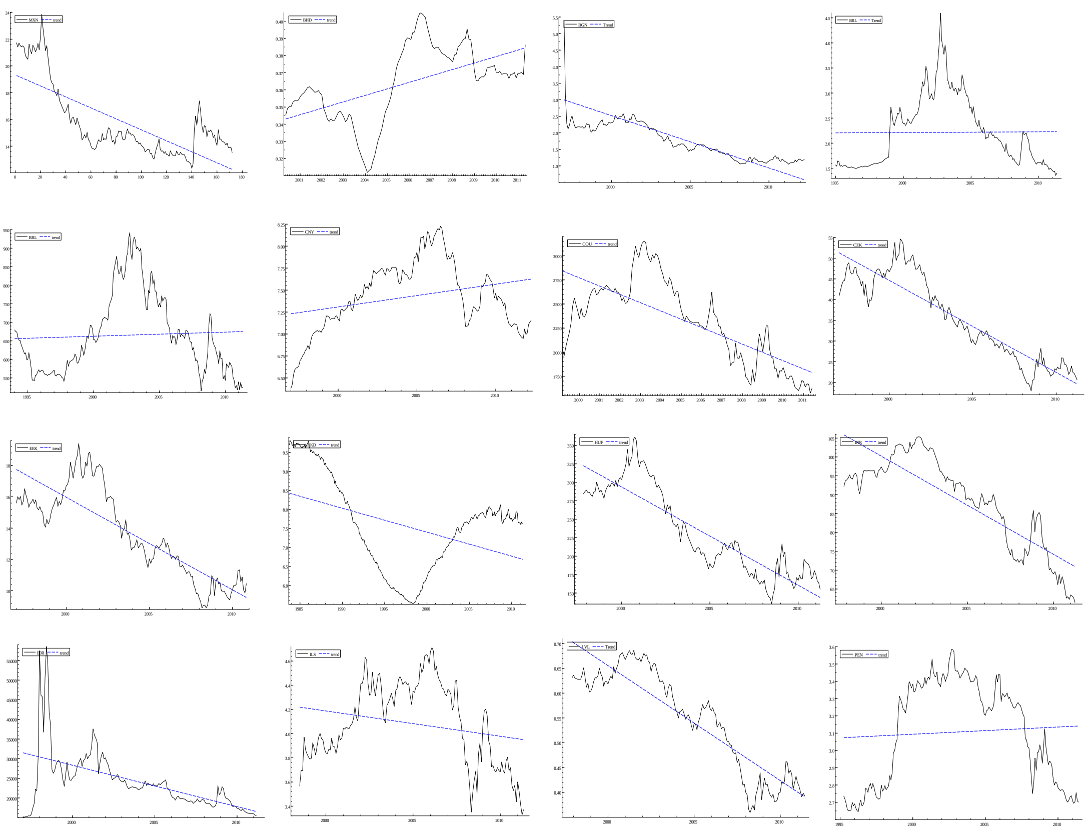


Figure 5.2: Developed Countries Real Exchange Rates with Fitted Time Trends

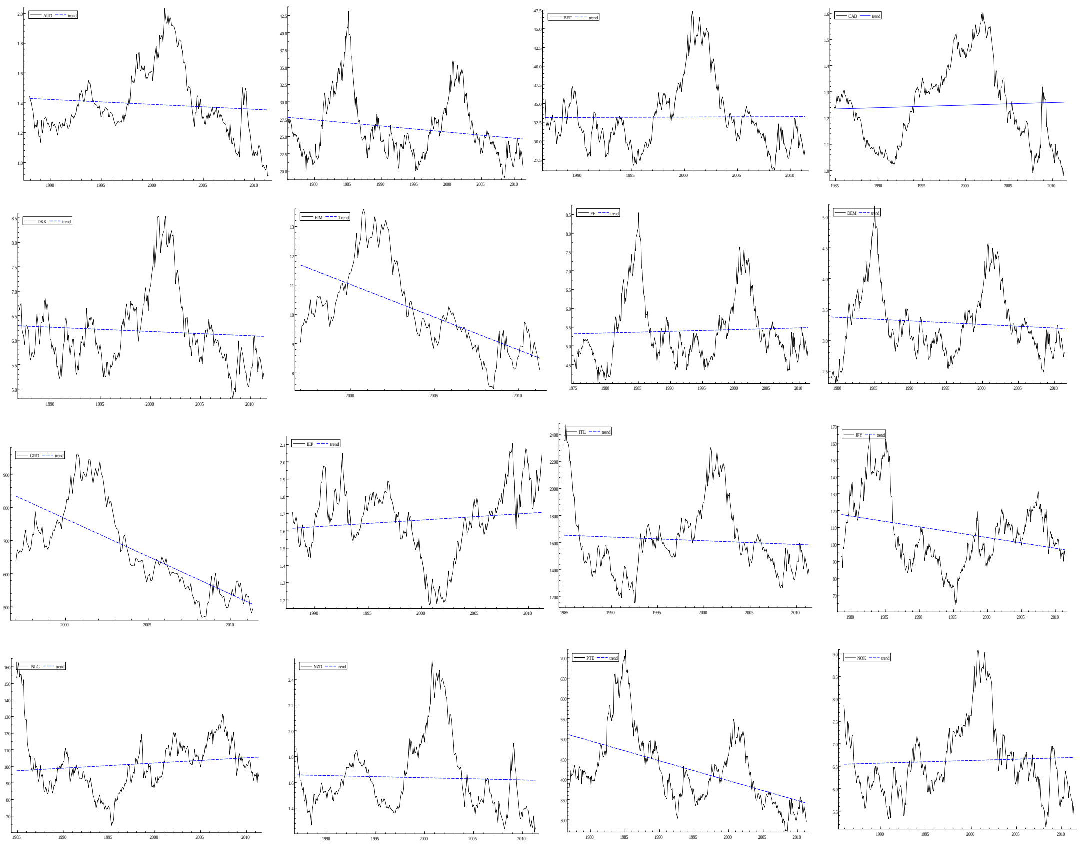


Figure 5.3: Average Deviations from Benchmark across Different Country Groups

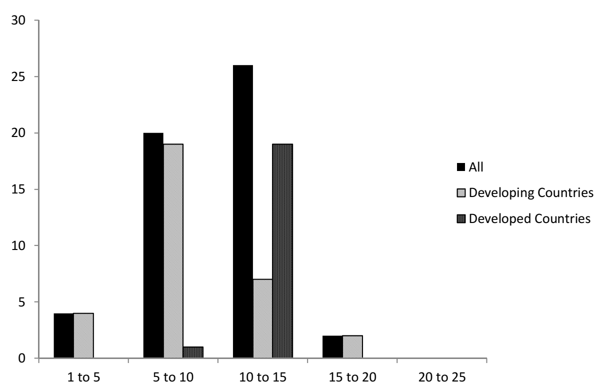


Table 5.2: Threshold Cointegration Model Estimation Results

Emerging Markets	Threshold Estimates Low	Threshold Estimates High	Band, %	Developed Markets	Threshold Estimates Low	Threshold Estimates High	Band, %
Argentina	-3.43	5.48	8.92	Australia	-0.6	16.99	17.59
Bahrain	-3.59	1.17	4.76	Austria	0.26	16.6	16.34
Brazil	-1.21	23.87	21.66	Belgium	-6.72	12.13	18.85
Bulgaria	-6.16	3.7	9.86	Canada	-7.9	3.48	11.38
Chile	-9.52	15.45	24.97	Denmark	-1.74	14.32	16.06
China	-6.1	1.97	8.07	Finland	-1.33	6.08	7.41
Colombia	-11.47	0.8	12.27	France	-1.23	15.58	16.81
Czech Rep	-7.85	5.46	13.33	Germany	0.17	16.45	16.28
Estonia	-7.76	2.46	10.22	Greece	0.14	10.32	10.18
Hong Kong	-4.86	13.17	8.31	Ireland	-1.74	6.29	8.03
Hungary	-3.21	7.28	10.49	Italy	1.69	16.37	14.68
India	-0.97	7.15	8.12	Japan	-0.36	18.44	18.81
Indonesia	-0.03	8.17	8.2	Netherlands	-10.27	19.89	30.16
Israel	-7.69	1.33	9.02	New Zealand	-12.83	11.38	24.21
Korea	-0.35	9.45	9.8	Norway	-5.98	2.02	8
Latvia	-7.91	-2.49	5.42	Portugal	-10.59	12.19	22.78
Lithuania	-3.57	3.7	7.27	Spain	-10.07	0.45	10.52
Malaysia	-4.93	-0.89	4.04	Sweden	-0.29	13.32	13.61
Mexico	-7.96	4.74	12.7	Switzerland	-14.3	10.75	25.05
Peru	2.74	7.24	9.96	U.K.	-11.8	5.64	17.44
Philippines	-7.09	2.52	9.61				
Poland	-9.65	0.09	9.74				
Romania	-2.19	4.9	7.09				
Russia	-20.93	0.24	21.17				
Saudi Arab.	-0.49	5.26	5.75				
Singapore	-5.23	3.68	8.91				
Slovak Rep	-9.38	2.95	12.33				
Slovenia	2.21	11.17	8.96				
S. Africa	-5.33	11.02	16.35				
Taiwan	-0.17	3.83	4				
Thailand	-2.13	6.63	8.76				
Turkey	-2.48	7.35	9.83				

Figure 5.4: Industrial Countries Threshold Bands

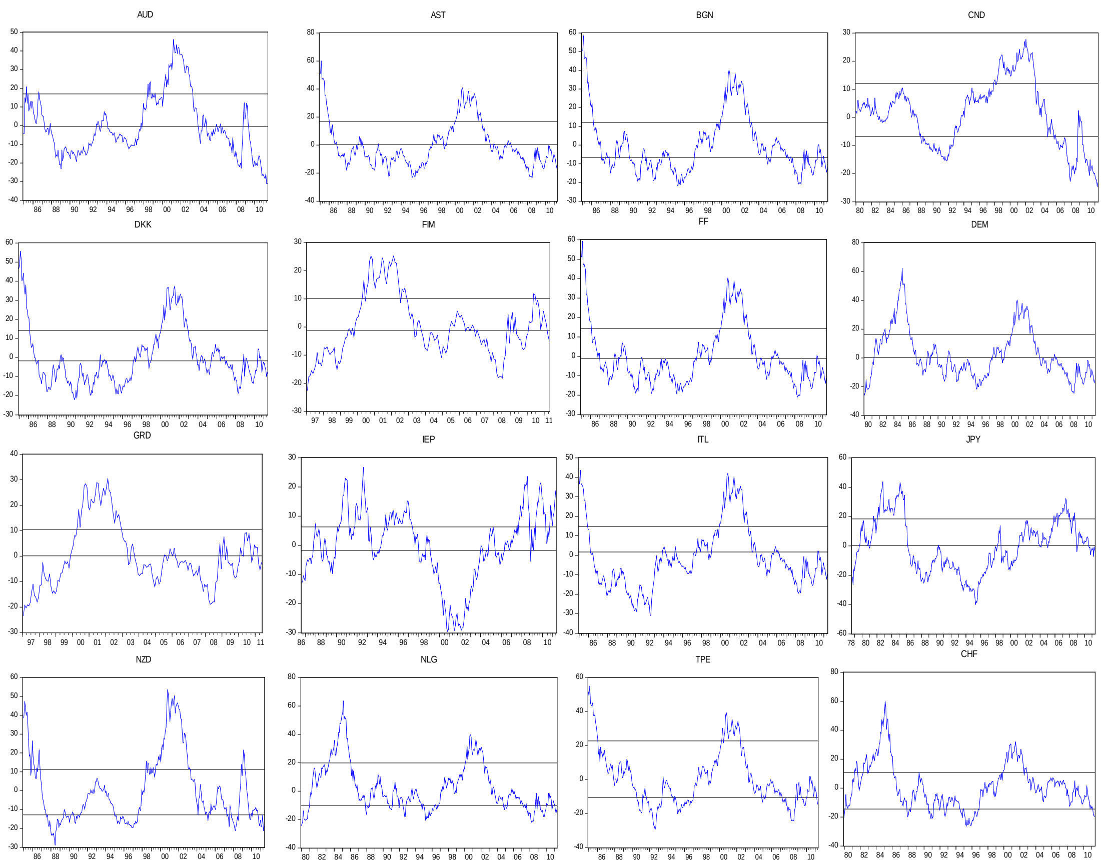


Figure 5.5: Emerging Markets Threshold Bands

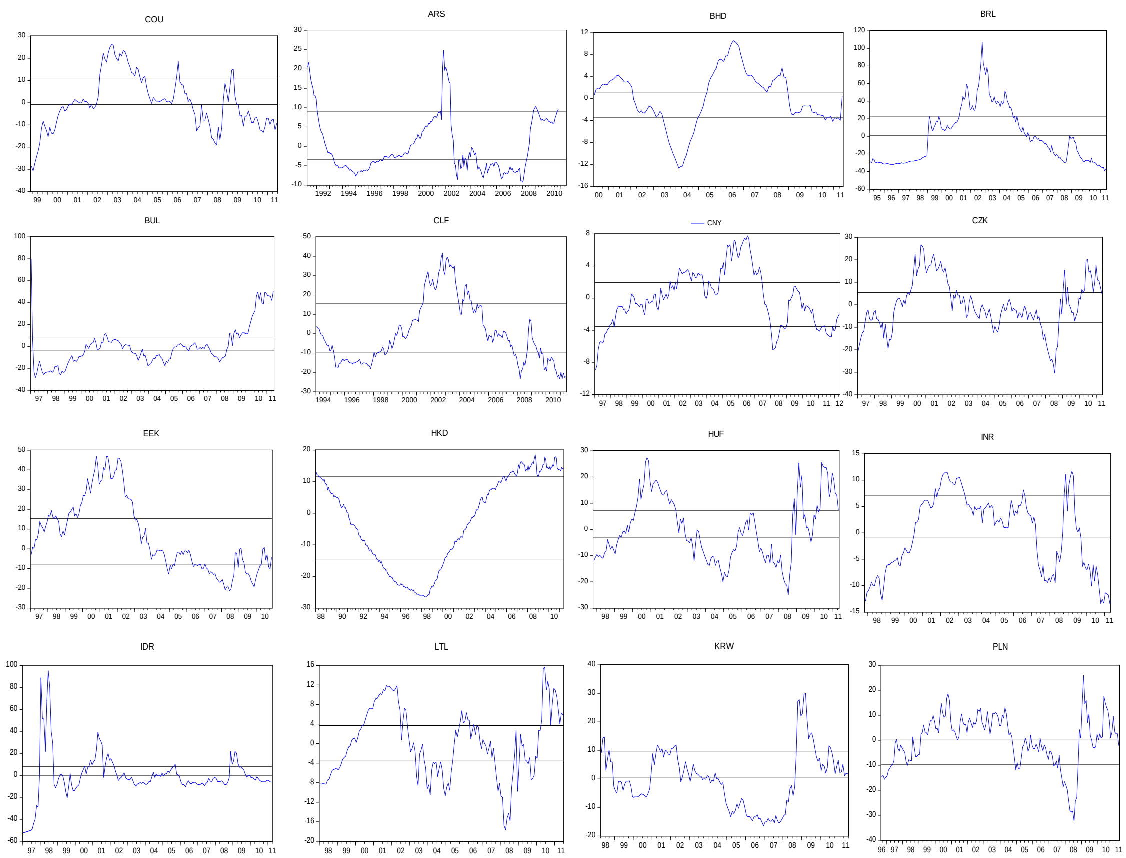


Table 5.3: ADF Unit Root Test Rejections

Developing Countries	Lag (trend)	q_t	Lag (trend)	Δq_t	Developed Countries	Lag (trend)	q_t	Δq_t
Argentina	4(WT)	-3.31*	3(WT)	-5.78***	Australia	0(NT)	-1.31	-18.4***
Bahrain	2(WT)	-2.36	1(NT)	-3.44**	Austria	0(NT)	-1.79	-20.74***
Brazil	1(NT)	-1.51	0(NT)	-11.33***	Belgium	0(NT)	-1.88	-18.94***
Bulgaria	3(WT)	-4.62***	3(NT)	-11.27***	Canada	0(NT)	-1.139	-20.04***
Chile	0(NT)	-1	0(NT)	-12.42***	Denmark	0(NT)	-3.59*	-16.86***
China	0(NT)	-2.67*	0(NT)	-17.97***	Finland	0(NT)	-1.18	-12.91***
Colombia	1(WT)	-3.33*	0(NT)	-9.81***	France	0(NT)	-2.15	-18.56***
Czech Rep	0(WT)	-3.46*	0(NT)	-13.16***	Germany	0(WT)	-2.23	-18.12***
Estonia	0(NT)	-2.71*	0(NT)	-12.61***	Greece	0(NT)	-2.41	-13.43***
Hong Kong	0(WT)	-0.77	0(WT)	-16.41***	Ireland	0(NT)	-1.95	-15.78***
Hungary	0(WT)	-2.3	0(NT)	-12.80***	Italy	0(NT)	-1.72	-18.23***
India	0(WT)	-1.92	0(NT)	-11.85***	Japan	0(NT)	-1.91	-18.88
Indonesia	8(WT)	-7.17***	9(NT)	-5.05***	Netherlands	0(NT)	-2.2	-18.86***
Israel	0(WT)	-1.92	0(NT)	12.28***	New Zealand	0(NT)	-2.45	-16.29***
Korea	2(NT)	-2.38	1(NT)	-10.04***	Norway	0(NT)	-2.88	-16.22***
Latvia	0(WT)	-2.16	0(NT)	-12.98***	Portugal	0(NT)	-4.80***	-17.70***
Lithuania	0(WT)	-2.39	0(NT)	-12.46***	Spain	0(NT)	-1.66	-16.44***
Malaysia	0(WT)	-4.05***	0(NT)	-9.28***	Sweden	0(NT)	-2.09	-17.35***
Mexico	0(NT)	-2.03	0(NT)	-12.22***	Switzerland	0(NT)	-1.79	-18.38***
Peru	0(WT)	-0.76	0(NT)	-12.18***	U.K.	0(NT)	-2.72	-18.92***
Philippines	1(WT)	-2.21	0(NT)	-10.0***				
Poland	0(WT)	-3.16*	0(NT)	-12.20***				
Romania	0(WT)	-5.97***	0(NT)	-15.05***				
Russia	1(WT)	-2.19	0(NT)	-10.14***				
Saudi Arab.	1(NT)	-1.5	0(NT)	-12.69***				
Singapore	0(NT)	-0.85	0(NT)	-17.09***				
Slovak Rep	0(WT)	-1.63	0(NT)	-13.79***				
Slovenia	0(NT)	-2.11	0(NT)	-14.08***				
South Africa	0(WT)	-2.36	0(NT)	-16.64***				
Taiwan	0(WT)	-3.96**	0(NT)	-11.74***				
Thailand	2(WT)	-2.94	0(NT)	-12.09***				
Turkey	0(WT)	-2.81	0(NT)	-11.68***				

Notes: The lag order is selected using the AIC (a maximum lag 512 is allowed for).
For WT, the test includes a time trend (which is significant at 10% level or better). For NT, the test includes no time trend.
Critical values for the ADF and DF-GLS tests are based on Cheung and Lai (1995a), (1995b).
*, **, *** denotes significance at the 10%, 5% and 1% level.

Table 5.4: Half-Live Estimates for Industrial and Less Developed Countries

Developing Countries	$\alpha =$ $(1-\rho_1)$	ρ_1	Half-life	Developed Countries	$\alpha =$ $(1-\rho_1)$	ρ_1	Half-life
Argentina	-0.04	0.96	1.39	Australia	-0.02	0.98	3.64
Bahrain	-0.03	0.97	1.89	Austria	-0.02	0.98	3.46
Brazil	-0.02	0.98	2.97	Belgium	-0.02	0.98	3.51
Bulgaria	-0.29	0.71	0.23	Canada	-0.01	0.99	5.11
Chile	-0.02	0.98	3.35	Denmark	-0.04	0.96	1.5
China	-0.03	0.97	1.99	Finland	-0.02	0.98	2.95
Colombia	-0.07	0.93	0.83	France	-0.02	0.98	3.11
Czech Rep	-0.07	0.93	0.81	Germany	-0.02	0.98	3.21
Estonia	-0.05	0.95	1.21	Greece	-0.05	0.95	1.26
Hong Kong	-0.02	0.98	2.89	Ireland	-0.03	0.97	2.04
Hungary	-0.06	0.94	1.01	Italy	-0.02	0.98	3.63
India	-0.04	0.96	1.62	Japan	-0.02	0.98	3.14
Indonesia	-0.45	0.55	0.16	Netherlands	-0.02	0.98	2.97
Israel	-0.04	0.96	1.32	New Zealand	-0.03	0.97	2.26
Korea	-0.05	0.95	1.14	Norway	-0.04	0.96	1.66
Latvia	-0.05	0.95	1.26	Portugal	-0.03	0.97	2.16
Lithuania	-0.06	0.94	0.96	Spain	-0.02	0.98	3.07
Malaysia	-0.29	0.71	0.23	Sweden	-0.03	0.97	2.26
Mexico	-0.04	0.96	1.62	Switzerland	-0.02	0.98	3.05
Peru	-0.06	0.94	1	U.K.	-0.03	0.97	2.03
Philippines	-0.03	0.97	2.24				
Poland	-0.09	0.91	0.69				
Romania	-0.06	0.94	0.93				
Russia	-0.04	0.96	1.57				
Saudi Arabia	-0.01	0.99	5.31				
Singapore	-0.01	0.99	7.73				
Slovak Rep	-0.02	0.98	2.58				
Slovenia	-0.05	0.95	1.22				
S. Africa	-0.04	0.96	1.62				
Taiwan	-0.05	0.95	1.1				
Thailand	-0.03	0.97	1.94				
Turkey	-0.08	0.92	0.79				

Notes: Persistence in exchange rate deviations is computed as the half-life (in years) of shocks to parity.
ρ_1 is autocorrelation coefficient.

Table 5.5: Correlation between the Persistence of Swings and the Forward Bias

Correlation Matrix	Ave. Dev. from Trend	t-stats and p-val.	R^2	Thresh. Band	t-stats and p-val.	R^2	Half-Life Dev.	t-stats and p-val.	R^2
BF Coefficient, $\hat{\beta}$	-0.538***	-4.523 (0.000)	0.14	-0.439***	-3.453 (-0.001)	0.2	-0.51**	-2.53 (-0.01)	0.11
Size of the Bias, $\|1-\hat{\beta}\|$	0.6597***	6.208*** (0.000)	0.33	0.564***	4.826 (0.000)	0.35	0.528**	2.41 (-0.01)	0.1
Size of the Bias with Structural Breaks, $ave\|1-\hat{\beta}\|$	0.7511***	6.98*** (0.000)	0.43	0.597***	5.32 (0.000)	0.37	0.633***	3.25 (-0.002)	0.18

Notes: Reported coefficient is the Spearman rank order correlation coefficient with its t-statistics and p-values in parentheses.
*, **, *** denotes significance at the 10%, 5% and 1% level. R^2 is obtained from regressing the forward bias on each measure of the persistence of exchange rate swings.